ME-6211

TECHNICAL MANUAL

REGULATED POWER SUPPLIES FOR RFCI MFR WITH S/N 1-31

(POWER/MATE)

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ME-6211

TECHNICAL MANUAL

REGULATED POWER SUPPLIES FOR RFCI MFR WITH S/N 1-31

(POWER/MATE)

December 10, 1973

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Contract NAS5-23000

LIST OF EFFECTIVE PAGES

TOTAL NUMBER OF PAGES IS 86 , AS FOLLOWS :

Page No.	*Issue*	*Page No.*	*Issue*
Title	Original		
A	Original		
i through ii	Original		
1-1 through 1-4	Original		
2-1/2-2	Original		
3-1 through 3-4	Original		
4-1 through 4-20	Original		
5-1 through 5-16	Original		
6-1 through 6-30	Original		
7-1 through 7-4	Original		
Type Face Specimen Sheet	Original		

* The asterisk indicates pages revised, added or deleted by the current change.

TABLE OF CONTENTS

Para. No.	Title	Page
	SECTION I. GENERAL DESCRIPTION	
1-1	Introduction	1-1
1-2	Purpose of the Manual	1-1
1-4	Major Components and Associated Equipment	1-1
1-6	Purpose of Equipment	1-1
1-11	Physical Description	1-3
1-13	Functional Description	1-3
1-15	Condensed Data	1-3
1-16	Test Equipment Required	1-3
1-18	Tools Required	1-3
1-20	Specifications	1-3
	SECTION II. INSTALLATION	
2-1	General	2-1
	SECTION III. OPERATION	
3-1	General	3-1
3-3	Operating Controls and Indicators	3-1
3-5	Initial Turn-on Procedures, Tests, and Adjustments	3-1
3-7	Normal Turn-on Procedure	3-1
3-10	Emergency Operation	3-4
	SECTION IV. THEORY OF OPERATION	
4-1	General	4-1
4-3	MFR Power Supply Drawer A1	4-1
4-5	+28 V dc Regulated Power Supply A1A1	4-1
4-7	+15 V dc Regulated Power Supply A1A2	4-3
4-9	-15 V dc Regulated Power Supply A1A3	4-7
4-11	Interaction of +15 V and -15 V Power Supplies During Turn-on	4-11
4-12	+5.5 V dc Regulated Power Supply A1A4	4-11
4-14	Precision Voltage Regulator Integrated Circuit (μA723)	4-20
	SECTION V. MAINTENANCE	
5-1	General	5-1
5-3	Preventive Maintenance	5-1
5-5	Corrective Maintenance	5-1
5-7	General Guidelines and Procedures	5-1
5-9	Troubleshooting Guides and Voltage Charts	5-2
5-11	Disposition of Replaced Components	5-2
5-13	Minimum Performance Standards	5-2
	SECTION VI. REPLACEABLE PARTS LIST	
6-1	General	6-1
	SECTION VII. DRAWINGS	
7-1	General	7-1

LIST OF ILLUSTRATIONS

Figure	Title	Page
1-1	Regulated Power Supplies, RFCI MFR	1-2
3-1	Operating Controls and Indicators, Front Panel	3-2
3-2	Operating Controls, Indicators, and Test Points, Test Point Panel	3-3
4-1	MFR Power Supply Drawer A1 Block Diagram	4-2
4-2	+28 V dc Regulated Power Supply A1A1 Block Diagram	4-4
4-3	+28 V dc Regulated Power Supply A1A1 Schematic Diagram	4-5

LIST OF ILLUSTRATIONS (Cont)

Figure	Title	Page
4-4	+15 V dc Regulated Power Supply A1A2 Block Diagram	4-8
4-5	+15 V dc Regulated Power Supply A1A2 Schematic Diagram	4-9
4-6	-15 V dc Regulated Power Supply A1A3 Block Diagram	4-12
4-7	-15 V dc Regulated Power Supply A1A3 Schematic Diagram	4-13
4-8	+5.5 V dc Regulated Power Supply A1A4 Block Diagram	4-16
4-9	+5.5 V dc Regulated Power Supply A1A4 Schematic Diagram	4-17
4-10	Equivalent Circuit, Lead Configuration, and Maximum Ratings of μA723	4-19
5-1	Location of Power Supply Drawer A1 Components	5-3
5-2	Test Connections for Monitoring Power Supply Voltage and Current	5-5
6-1	Power Supply A1A1, Exploded View	6-4
6-2	Power Supply Printed Circuit Board A1A1A1, Parts Location	6-6
6-3	Power Supply Printed Circuit Board A1A1A2, Parts Location	6-9
6-4	Power Supply A1A2, Exploded View	6-12
6-5	Power Supply Printed Circuit Board A1A2A1, Parts Location	6-16
6-6	Power Supply A1A3, Exploded View	6-18
6-7	Power Supply Printed Circuit Board A1A3A1, Parts Location	6-20
6-8	Power Supply Printed Circuit Board A1A3A2, Parts Location	6-22
6-9	Power Supply Printed Circuit Boards A1A3A3 and A1A3A4, Parts Location	6-24
6-10	Power Supply A1A4, Exploded View	6-26
6-11	Power Supply Printed Circuit Board A1A4A1 Parts Location	6-29

LIST OF TABLES

Table	Title	Page
1-1	Major Components and Associated Equipment	1-1
1-2	Physical Characteristics	1-3
1-3	Test Equipment Required for MFR Power Supply Drawer A1	1-3
1-4	General Specifications for MFR Regulated Power Supplies	1-4
3-1	Operating Controls, Indicators, and Test Points	3-1
5-1	Troubleshooting Guide and Voltage Charts	5-2
5-2	+28 V dc (A1A1) Troubleshooting Guides	5-6
5-3	+28 V dc (A1A1) Voltage Chart	5-6
5-4	+15 V dc (A1A2) Troubleshooting Guide	5-7
5-5	+15 V dc (A1A2) Voltage Chart	5-8
5-6	-15 V dc (A1A3) Troubleshooting Guide	5-8
5-7	-15 V dc (A1A3) Voltage Chart	5-9
5-8	+5.5 V dc (A1A4) Troubleshooting Guide	5-9
5-9	+5.5 V dc (A1A4) Voltage Chart	5-10
5-10	Minimum Performance Standards	5-11
6-1	Parts List Reference Index	6-1
7-1	List of Drawings	7-1

SECTION I
GENERAL DESCRIPTION

1-1. INTRODUCTION.

1-2. PURPOSE OF THE MANUAL

1-3. This technical manual provides the necessary information for the operation and maintenance of the multifunction receiver (MFR) regulated power supplies, located in the MFR Power Supply Drawer A1. (See figure 1-1.) The information is provided through physical and functional descriptions, operating instructions, theory of operation, maintenance instructions and replaceable parts information, along with pertinent block and schematic diagrams. The manual was prepared for the National Aeronautics and Space Administration (NASA) by the Bendix Field Engineering Corporation, Columbia, Maryland 21045, under contract NAS5-23000.

1-4. MAJOR COMPONENTS AND ASSOCIATED EQUIPMENT

1-5. Major components and associated equipment information is provided in table 1-1.

Table 1-1. Major Components and Associated Equipment

REFERENCE DESIGNATION	TITLE	NASA MANUAL NUMBER
	Multifunction Receivers	ME-5795
A1A1	+28 V dc Power Supply (Model OEM 28A-P1823)	ME-6211
A1A2	+15 V dc Power Supply (OEM 15F-C-P1820)	ME-6211
A1A3	-15 V dc Power Supply (PXS-C-15V-15A)	ME-6211
A1A4	+5.5 V dc Power Supply (PL1-5-5-P1822)	ME-6211

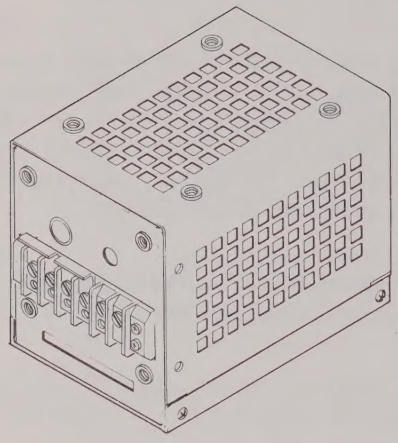
1-6. PURPOSE OF EQUIPMENT (See figure 4-1.)

1-7. The MFR Power Supply Drawer A1 contains four regulated and two unregulated power supplies. The four regulated power supply voltages are: +28 V dc, +15 V dc, -15 V dc, and +5.5 V dc. The two unregulated power supply voltages are: +24 V dc and +200 V dc. This manual will include some information on the unregulated power supplies as reference data pertinent to the discussion of the regulated power supplies.

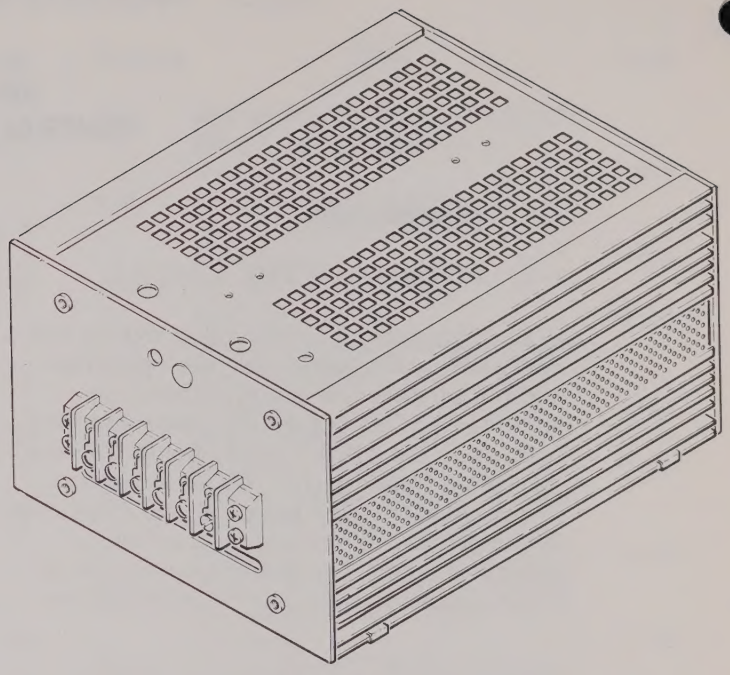
1-8. The +28 V dc regulated power supply (A1A1) provides power for the frequency standard ovens within the MFR. This power supply is independent of Power Supply Drawer A1 POWER ON switch, and it remains energized at all times.

1-9. The +15 V dc and -15 V dc regulated power supplies (A1A2 and A1A3, respectively) provide regulated power to various MFR circuits. These power supplies are activated by Power Supply Drawer A1 POWER ON switch.

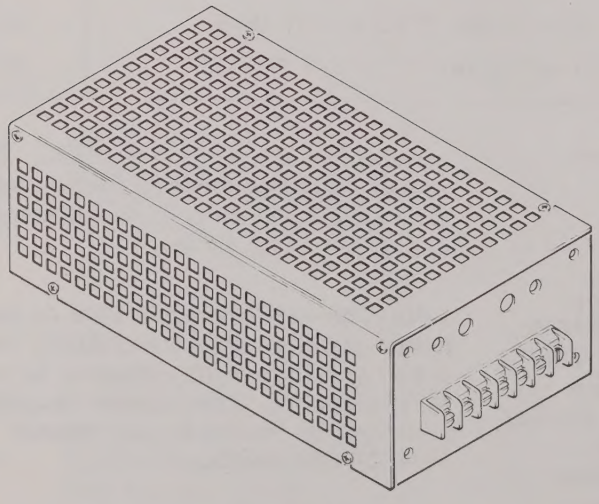
1-10. The +5.5 V dc regulated power supply (A1A4) also provides regulated power to various MFR circuits and is controlled by the A1 POWER ON switch.



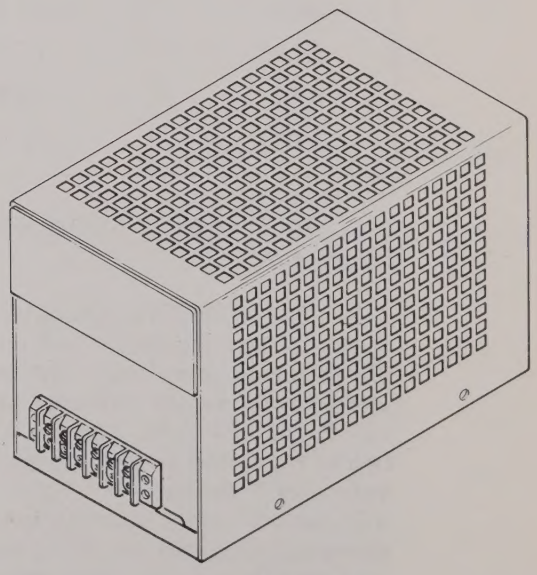
+28VDC
REGULATED POWER SUPPLY
A1A1



+15 VDC
REGULATED POWER SUPPLY
A1A2



–15 VDC
REGULATED POWER SUPPLY
A1A3



+5.5 VDC
REGULATED POWER SUPPLY
A1A4

Figure 1–1. Regulated Power Supplies, RFCI MFR

1–11. PHYSICAL DESCRIPTION.

1-12. A list of the physical characteristics of the MFR regulated power supplies is provided in table 1-2.

1–13. FUNCTIONAL DESCRIPTION.

1-14. MFR regulated power supplies A1A1, A1A2, A1A3, and A1A4 are solid-state devices, utilizing constant voltage/current limiting circuitry. All supplies require an input of 115 ±10 V ac at 47 to 420 Hz. Each supply contains overload and short-circuit protection circuitry, and the +5.5 V dc and the -15 V dc power supplies include over-voltage protection circuits. Additional specifications are provided in table 1-4.

Table 1–2. Physical Characteristics

REFERENCE DESIGNATION	NAME	WIDTH	HEIGHT	DEPTH	WEIGHT	FIGURE NO.
A1A1	+28 V dc	3 5/16"	3 7/8"	5 1/8"	3.75 lbs	1-1
A1A2	+15 V dc	7 1/2 "	5 1/8"	9 3/8"	19.5 lbs	1-1
A1A3	-15 V dc	4 7/8 "	3 1/4"	9 3/8"	8.5 lbs	1-1
A1A4	+5.5 V dc	4 1/2 "	5 1/2"	8"	9.75 lbs	1-1

1–15. CONDENSED DATA.

1-16. TEST EQUIPMENT REQUIRED

1-17. Required test equipment is listed in table 1-3.

Table 1–3. Test Equipment Required for MFR Power Supply Drawer A1

EQUIPMENT	MANUFACTURER	MODEL	OPERATING RANGE
Digital Voltmeter	Hewlett-Packard	3440A	0 - 60 V dc
Vaccum Tube Voltmeter	Hewlett-Packard	410CC	0 - 30 V dc
DC Ammeter	Weston	904	0 - 15 Amperes
Resistive Load	Leeds and Northrup	4360	165 Watt at 1.5 Ohms
True RMS Voltmeter	Hewlett-Packard	3400A	>1 MV RMS
VARIAC (with output voltage meter)			0 - 130 V ac
Equivalent equipment may be substituted when the above equipment is not available.			

1-18. TOOLS REQUIRED

1-19. Installation and maintenance of this equipment does not require special tooling.

1-20. SPECIFICATIONS

1-21. General specifications are included in table 1-4.

Table 1-4. General Specifications for MFR Regulated Power Supplies

FUNCTION	POWER SUPPLY MODEL			
	PL1-5-5-P1822 (+5.5 V dc)	OEM-15F-C-P1820 (+15 V dc)	PXS-C-15V-5A (-15 V dc)	OEM-28A-P1823 (+28 V dc)
OUTPUT VOLTAGE	4 - 6 V	13.5 - 16.5 V	13.5 - 16.5 V	26 - 30 V
OUTPUT CURRENT	0 - 5.0 Amp	0 - 11.0 Amp	0 - 5.0 Amp	0 - 0.5 Amp
REGULATION	>±0.1%	>±0.01% +1 mV	>±0.1%	>±0.005% or 1 mV
RIPPLE	<1 mV RMS	<250μ V	<1 mV RMS	<250μ V
RESPONSE TIME	<20μ sec	<20μ sec	<20 μ sec	<20μ sec
TEMPERATURE COEFFICIENT	>0.015%/°C	>0.01%/° C	>0.01%/° C	>0.025% for 8 hr.
POLARITY	+, -, or floating to 300 V	+, -, or floating to 300 V	+, -, or floating to 300 V	+, -, or floating to 300 V
AMBIENT OPERATING TEMPERATURE RANGE	-20° C to +71° C (-4° F to +160° F)	-20° C to +71° C (-4° F to +160° F)	-20° C to +71°C (-4° F to +160° F)	-20° C to +71°C (-4° F to +160° F)
STORAGE TEMPERATURE RANGE	-55° C to +85° C (-67° F to +185°F)	-55°C to +85° C (-67° F to +185° F)	-55°C to +85°C (-67° F to +185° F)	-55°C to +85° C (-67°F to +185° F)
SENSING	Remote/Local	Remote/Local	Remote/Local	Remote/Local

OUTPUT CURRENT vs TEMP: All units are rated at full output current at 45°C (113° F), and derated linearly to approximately 70% at 71° C (160°F).

LONG-TERM STABILITY: Average less than 0.025% for 8 hours for all units.

SECTION II
INSTALLATION

2–1. GENERAL.

2-2. The MFR regulated power supplies are installed in the MFR Power Supply Drawer A1 during assembly of the MFR. Removal and installation procedures are provided in paragraph 5-8 of Section V, Maintenance.

2-3. Instructions for disassembly and assembly of the power supplies for corrective maintenance are provided in Section V, Maintenance.

2-4. To minimize MFR downtime due to a power supply failure, it is recommended that replacement power supplies be withdrawn from the field station's logistics depot, checked for operational readiness, adjusted for proper output in accordance with Section V of this manual, and returned to the depot. Power supplies so processed should be tagged with the date of adjustment, the output voltage setting, and any other remarks pertinent to the operation of the power supply.

SECTION III
OPERATION

3–1. GENERAL.

3-2. This section provides the instructions for the operation of the MFR regulated power supplies under normal operating conditions. Due to the operating requirements of the MFR, emergency operation of power supplies is not recommended.

3–3. OPERATING CONTROLS AND INDICATORS.

3-4. A tabulation of operating controls and indicators is provided in table 3-1.

3–5. INITIAL TURN-ON PROCEDURES, TESTS, AND ADJUSTMENTS.

3-6. Initial turn-on procedures, tests, and adjustments will be accomplished during installation, and are defined by the applicable publication listed in table 1-1.

3–7. NORMAL TURN-ON PROCEDURE.

3-8. The MFR Power Supply Drawer A1 is under the control of the POWER ON circuit breaker (CB1) located on the drawer front panel. CB1 supplies 120 V ac to the

Table 3–1. Operating Controls, Indicators, and Test Points

FIGURE NUMBER	NAME	REFERENCE DESIGNATION	FUNCTION	LOCATION
3-1	POWER ON	CB1	Switches ac power	Front Panel
3-1	OVEN	DS1	Indicates power supply A1A1 energized	Front Panel
3-1	POWER	DS2	Indicates power supplies A1A2, A1A3, A1A4 energized	Front Panel
3-2	FUSE	F1	Protects 28 V regulated power power supply (A1)	Test Point Panel
3-2	FUSE	F2	Protects T1 (24 V and 200 V power supply)	Test Point Panel
3-2	TEST POINT 1	TP1	Monitors +28 V dc (power supply A1A1 output)	Test Point Panel
3-2	TEST POINT 2	TP2	Monitors +15 V dc (power supply A1A2 output)	Test Point Panel
3-2	TEST POINT 3	TP3	Monitors -15 V dc (power supply A1A3 output)	Test Point Panel
3-2	TEST POINT 4	TP4	Monitors +5.5 V dc (power supply A1A4 output)	Test Point Panel
3-2	TEST POINT 5	TP5	Monitors +24 V dc (filter A1C1 output)	Test Point Panel

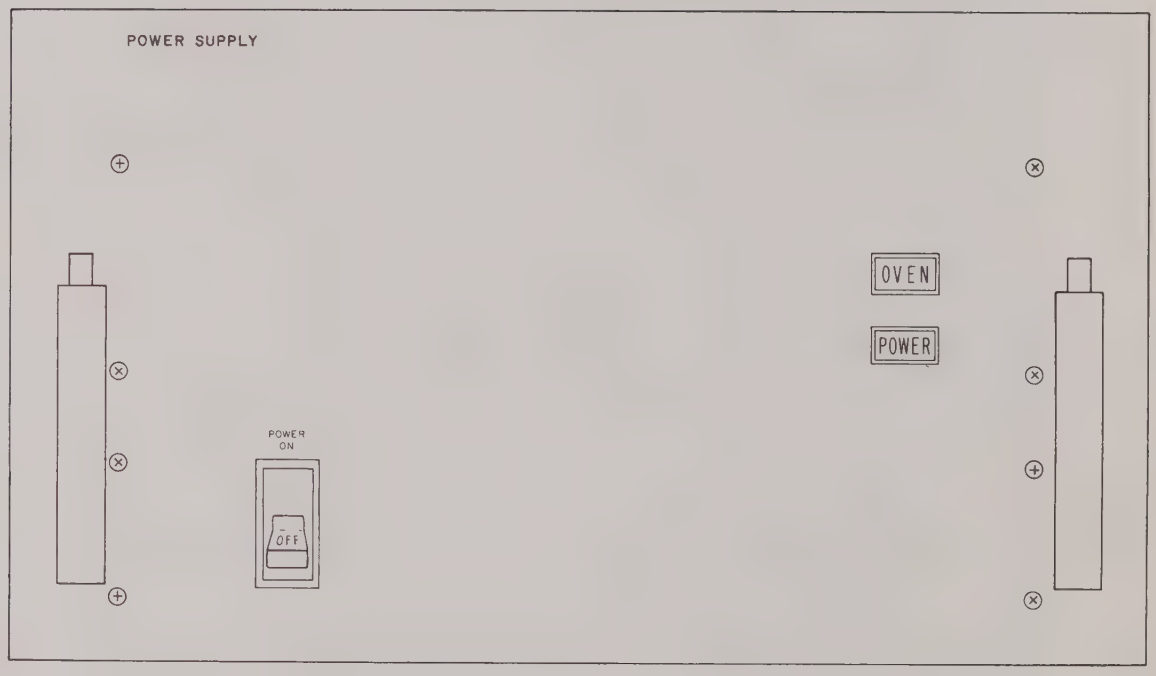


Figure 3–1. Operating Controls and Indicators, Front Panel

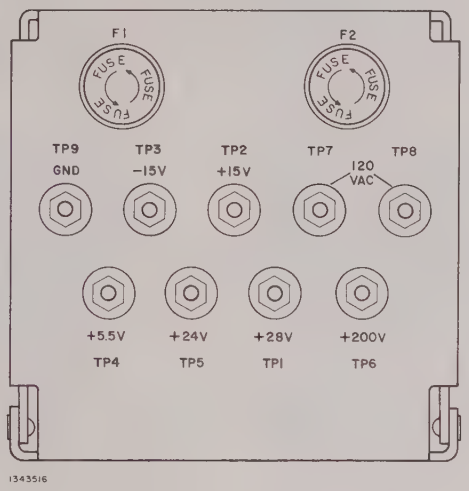


Figure 3–2. Operating Controls, Indicators, and Test Points, Test Point Panel

Table 3–1. Operating Controls, Indicators, and Test Points (Cont)

FIGURE NUMBER	NAME	REFERENCE DESIGNATION	FUNCTION	LOCATION
3-2	TEST POINT 6	TP6	Monitors +200 V dc (filter A1C2 output)	Test Point Panel
3-2	TEST POINT 7	TP7	Monitors 120 V ac to A1A2, A1A3, A1A4	Test Point Panel
3-2	TEST POINT 8	TP8	Monitors 120 V ac to A1A2, A1A3, A1A4	Test Point Panel
3-2	TEST POINT 9	TP9	Ground potential for test points 1 through 6.	Test Point Panel

+15 V dc, -15 V dc, +5.5 V dc, +24 V dc, and +200 V dc power supplies, with the +28 V dc power supply deriving its 120 V ac power directly from the MFR cabinet ac power. The +28 V dc power is utilized only for the frequency standard oven in the Signal Source Drawer A5; and it must remain on at all times. The ON status of the +28 V dc power supply is verified by the OVEN light (DS1) being lighted.

Note

During POWER ON turn-on, the POWER indicator (DS2) must be monitored. If the POWER indicator lights dimly, the POWER ON circuit breaker must be recycled back to OFF and again turned ON.

3-9. Occasionally, during Power Supply Drawer A1 activation, the protection circuits of the +15 V dc or -15 V dc power supply will inhibit the turn-on of either power supply. Should this occur, the POWER indicator (DS2) will light very dimly. Recycling of the POWER ON circuit breaker (CB1) as many times as required will result in a full turn-on of both supplies, verified by a normal indication of the POWER indicator (DS2).

3–10. EMERGENCY OPERATION.

3-11. A failed power supply can be replaced by the proper replacement power supply in approximately the same amount of time required to locate, connect, and adjust a laboratory power supply. Emergency operation is not recommended; complete replacement of a failed unit with its proper replacement is preferred.

SECTION IV
THEORY OF OPERATION

4–1. GENERAL.

4-2. This section describes the general theory of operation of the MFR Power Supply Drawer A1 as an integral unit of the MFR, and describes in detail the theory of operation of each of the four MFR regulated power supplies located in the MFR Power Supply Drawer A1.

4–3. MFR POWER SUPPLY DRAWER A1.

4-4. The simplified operation of the MFR Power Supply Drawer A1 is shown in figure 4-1. Incoming ac power to the MFR (nominal 120 V ac ±10 percent, 48 to 63 Hz) is applied to both fuse F1 and circuit breaker CB1. The fuse F1 protects the +28 V dc power supply A1A1, which is on whenever cabinet power is ON. Power supply A1A1 is used for the frequency standard oven in the signal source drawer A5. The circuit breaker CB1 is used as the MFR power control switch as well as a protective device for power supplies A1A2, A1A3, A1A4, and for transformer A1T1. Transformer A1T1, supplying ac power to the +200 V and +24 V unregulated supplies, is also protected by fuse F2 (physically located on the test point panel). Test points are provided for all dc and ac voltages, with the dc test points indicating the output of the power supplies, and the ac test points monitoring the ac power after the circuit breaker CB1 but prior to fuse F2. POWER ON circuit breaker CB1 must be ON in order that all dc and ac voltages can be monitored. Note that the +28 V dc output can be monitored when POWER ON circuit breaker CB1 is OFF. It should also be noted that presence of +28 V dc power is indicated by the OVEN indicator (DS1) being lighted. A brightly lighted POWER indicator (DS2) indicates that the +15 V dc and -15 V dc power supplies are ON. There is no provision for a front panel indication of the operation of the remaining power supplies.

4-5. +28 V DC REGULATED POWER SUPPLY A1A1. (See figures 4-2 and 4-3.) This constant voltage/current limiting power supply operates independently of POWER ON circuit breaker CB1 and provides +28 V dc at 0.5 amp to the signal source drawer A5 to activate the frequency standard oven. The power supply consists of the following circuits: an ac input circuit and transformer with one input and two output windings; a bias supply for the control circuit consisting of an auxiliary rectifier bridge, filter, and zener referenced regulator; and a main regulator circuit consisting of the main rectifier bridge and filter, a series regulator, a voltage comparator and amplifier, a current-sensing circuit and amplifier, and an output voltage-sensing circuit. In figure 4-2, the series regulator driver receives its base current from the bias supply constant voltage source through the essentially independent constant current source. Sufficient current is supplied to saturate the driver-regulator, with power supply regulation being accomplished by shunting as much current as required away from the series regulator driver. This shunting is performed by either the voltage comparator amplifier, the current-sensing amplifier, or both.

4-6. An ac input voltage is applied to transformer T1 through input terminals 5 and 6. T1 has two output windings. One output is rectified by CR6, filtered by C2, and regulated by Q7, CR11 (zener, 6.2 V) and CR12 (zener, 6.2 V) to provide an operating voltage for the control circuitry while R2 and CR10 (zener, 15 V) form a voltage preregulator for the constant current source composed of R3, CR11 (zener, 6.2 V), R4, and Q7. This source furnishes the series regulator driver, CR12 (zener, 6.2 V) and Q5/Q6 with a constant current that is essentially independent of line and load variations. The main transformer T1 output winding is rectified by the full-wave bridge composed of

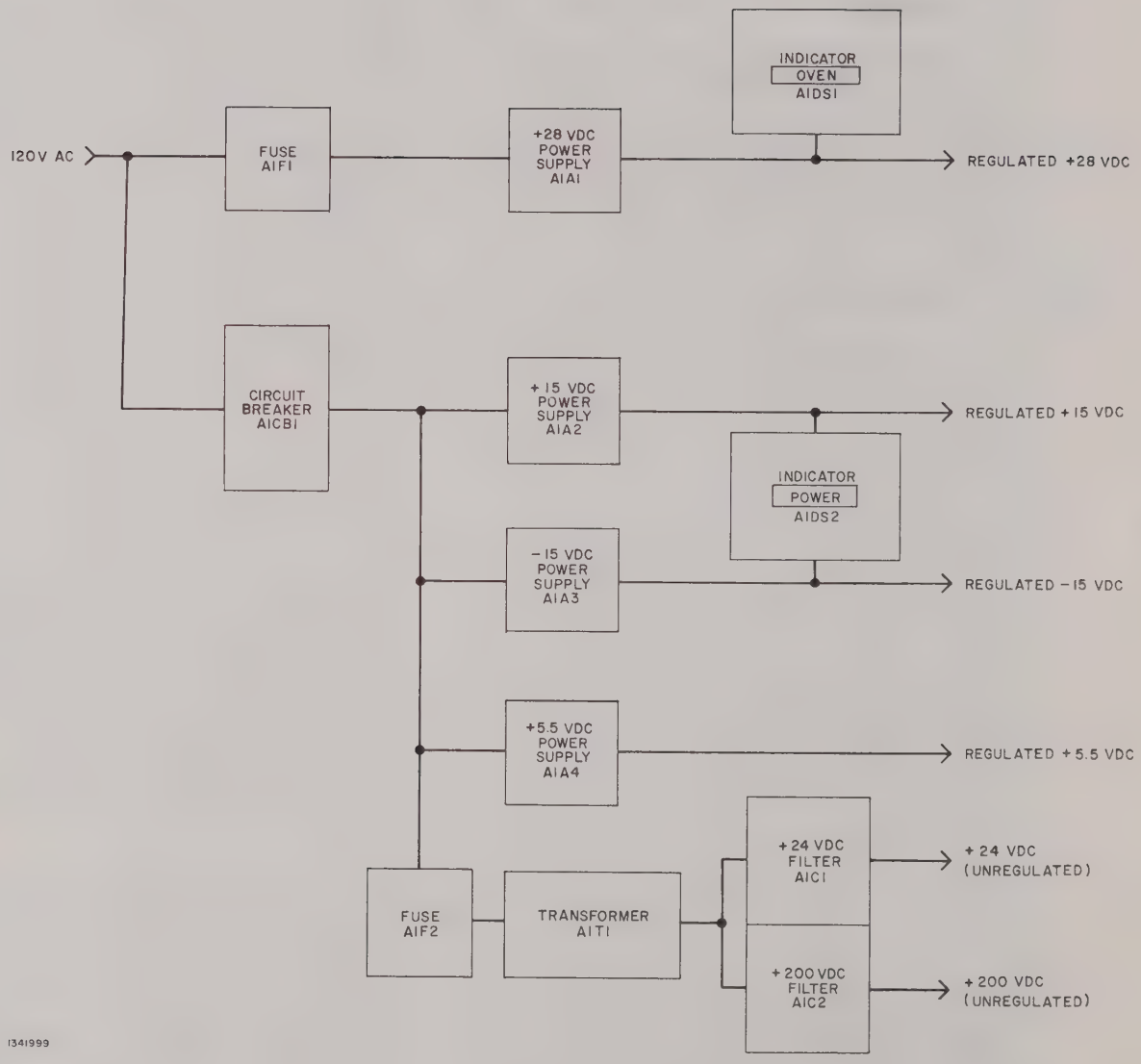


Figure 4-1. MFR Power Supply Drawer A1 Block Diagram

CR1 through CR4, filtered by C1 and R14, and regulated by the Darlington pair Q1 and Q2. Constant current applied to CR12 (zener 6.2 V) results in excellent voltage stability. The voltage across CR12 is divided by R5 and R6 and applied as a reference to the base of Q5. R19, R17, and R18 form a voltage divider at the base of Q6. The Q5/Q6 circuitry adjusts itself to keep the voltage on the bases of Q5 and Q6 equal. With the base of Q5 held at a constant reference voltage, any change in output voltage causes a change in the base emitter voltage of Q6 which, in turn, causes a change in the voltage across R16. Voltage changes across R16 control conduction of Q4, which shunts current away from the base of series regulator driver Q2. If the output starts to rise, Q6 conducts more heavily causing an increased voltage drop across R16 and more current to the base of Q4. This results in increased conduction of Q4, shunting current away from the base of Q2, resulting in a lower emitter current in Q1 and a reduction in output voltage. A drop in output voltage results in a reverse of the above process. The current monitoring circuit, Q3, R7, R8, R9, R10, C4, C5, CR13, and CR14, reduces the average output power in the event of an overload. During normal operation, C4 is charged through R7 and CR14. Output current is sensed as a voltage drop across R8. When the output current reaches a level sufficient to cause a voltage drop across R8 to exceed the sum of the forward voltage drops of CR14 and the emitter-to-base junction of Q3, Q3 begins to conduct. This conduction shunts current away from the base of Q2, causing Q1 to conduct less, thus reducing the output voltage. As the voltage drops, CR14 becomes back biased due to the charge on C4, which is then discharged through R10 and the emitter-to-base junction of Q3, causing Q3 to conduct less heavily. As C4 is discharging, Q3 approaches a steady state of conduction which shunts sufficient current away from the series regulator driver to lower the output voltage to a fraction of the normal output power. This steady state of conduction by Q3 continues until the overload is removed. The constant voltage and current source circuitry, although independent of line and load variations, is electrically connected to +OUT, which results in output voltage fluctuations appearing as a change in the -OUT voltage level rather than the +OUT voltage level. This results in an essentially constant current supply to the junction of Q4, CR13, and Q8, regardless of output voltage, and maintains the 6.2 V drop across CR12. Thus, in the event of a complete short circuit between -OUT and +OUT, the current necessary for the regulating circuitry is available within the power supply. R15, C7, and CR15 shunt +OUT to -OUT, providing a small constant load (R15), enhanced output impedance characteristics (C7), and protection against the application of a reversed voltage to the output taps (CR15).

4-7. +15 V DC REGULATED POWER SUPPLY A1A2. (See figures 4-4 and 4-5.) This constant voltage/current limiting power supply provides +15 V dc at 11.0 amperes to various MFR circuits, and is electrically configured in series with the -15 V dc power supply for some of the MFR circuits. Due to this configuration, these two power supplies can resist the turn-on of each other or of themselves. The power supply consists of the following circuits: an ac input circuit and transformer with one input and two output windings; a bias supply for the control circuit, consisting of a half-wave rectifier and filter; a constant current supply and amplifier; and a main regulator circuit consisting of a full-wave rectifier and filter circuit, series regulators, emitter follower drivers, voltage comparator and amplifier, and a current-sensing amplifier. In figure 4-4, the series regulator driver circuit receives its base and collector currents from the bias supply through the constant current and constant voltage sources, both essentially independent of line and load variations. Sufficient current is supplied to saturate the Darlington driver circuit, with regulation of the power supply being accomplished by shunting as much current as required away from the series regulator driver circuit. This shunting is performed by either the voltage comparator amplifier, the current-sensing amplifier, or both.

4-8. An ac input voltage is applied to transformer T1, which is protected by a thermal switch in the input circuit. T1 has two output windings, a bias voltage supply winding and the main supply winding. The bias

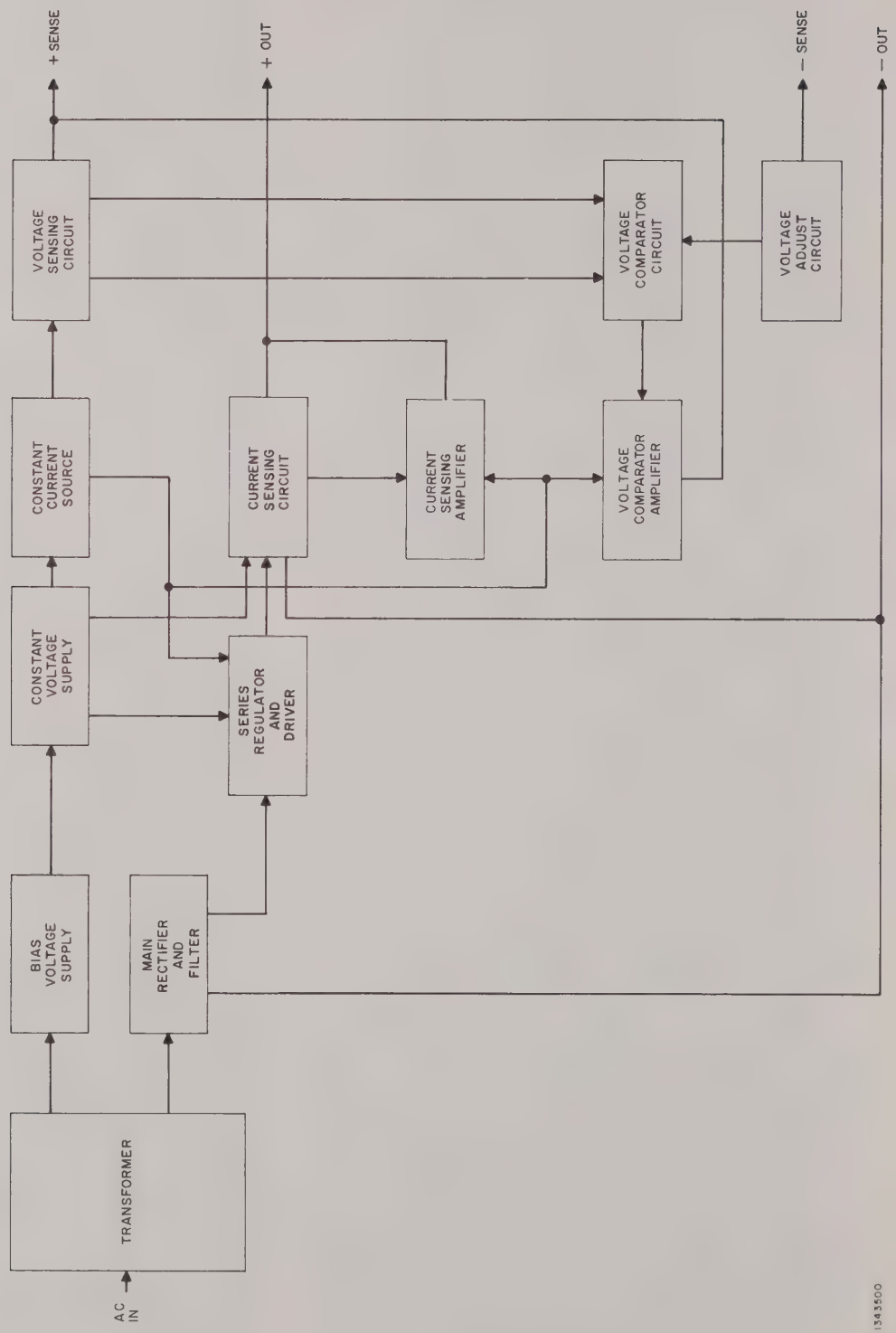
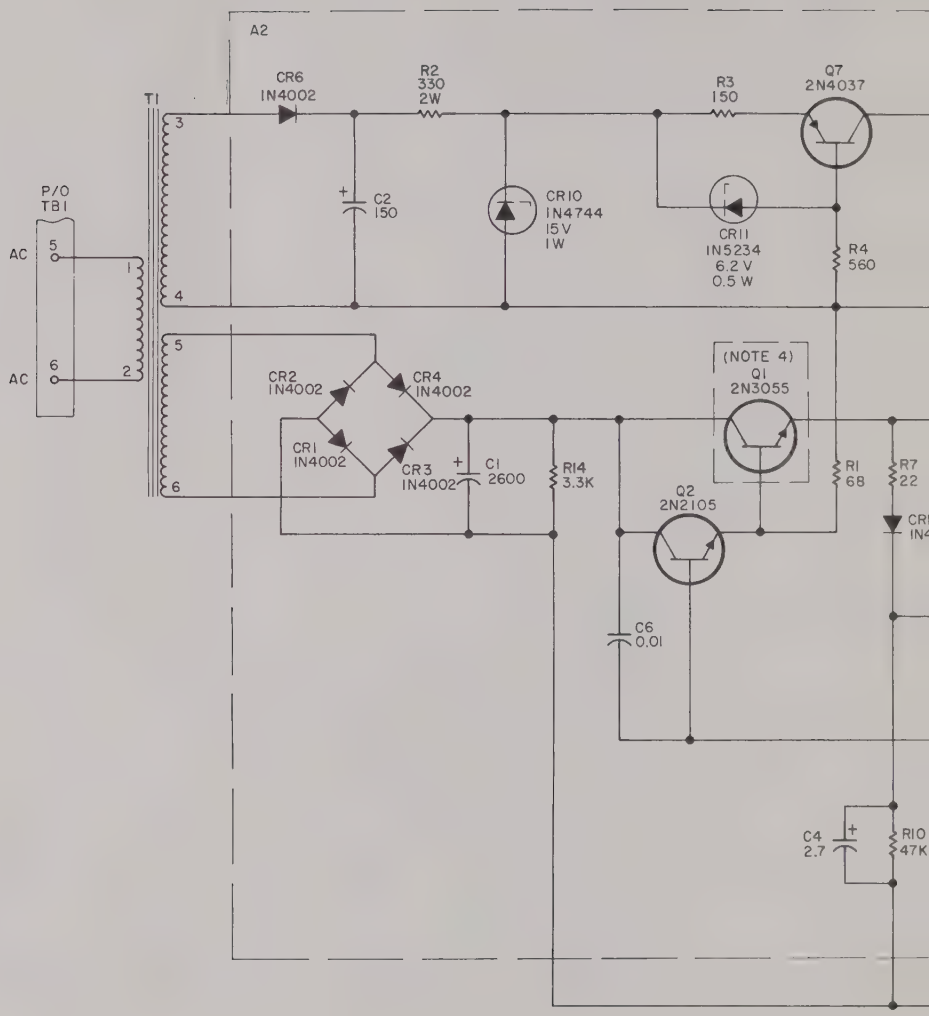
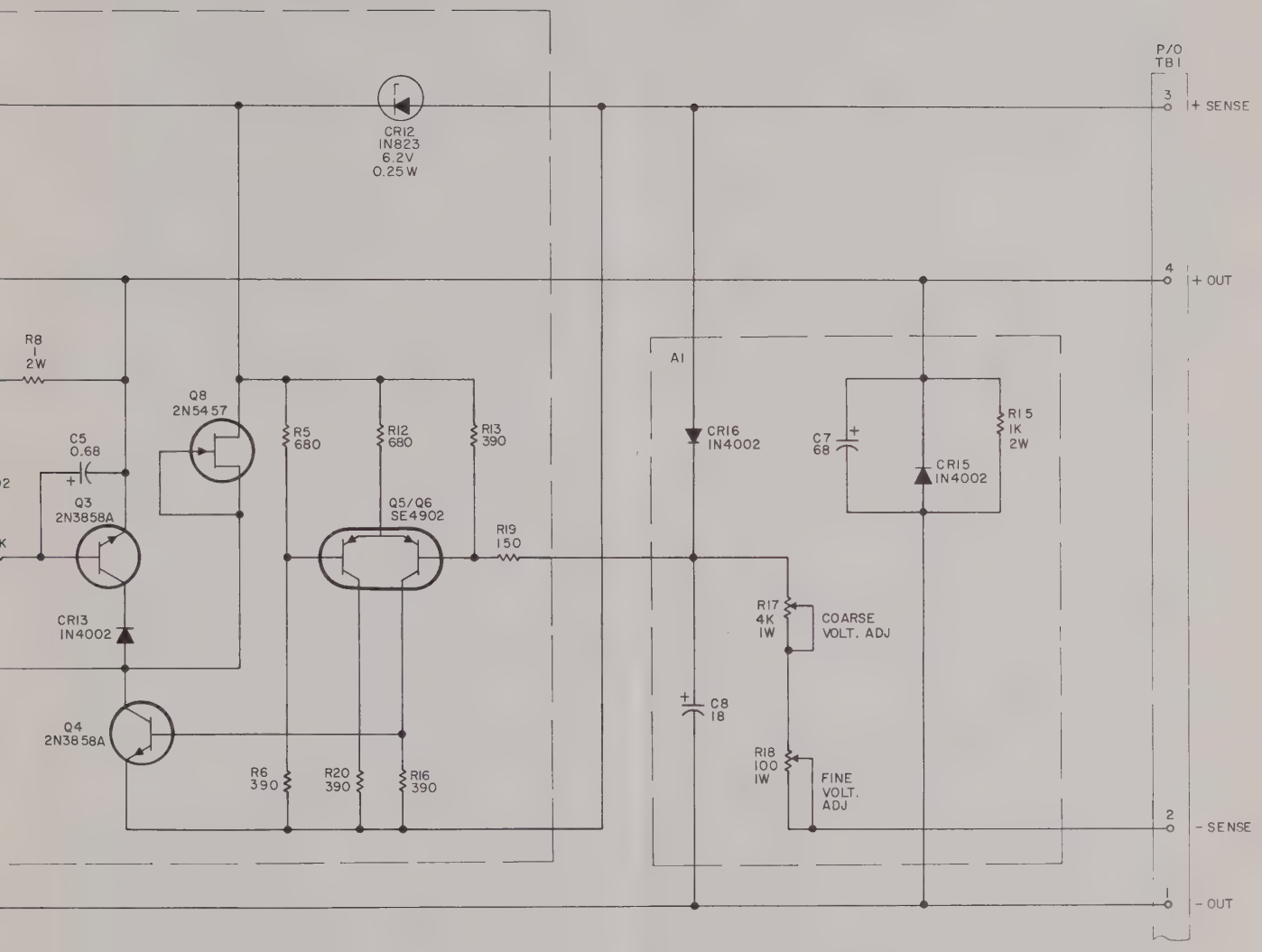


Figure 4–2. +28 V dc Regulated Power Supply A1A1 Block Diagram


A2
T1
P/O
TB1
AC
AC
CR6
IN4002
R2
330
2W
R3
150
Q7
2N4037
C2
150
CR10
IN4744
15V
1W
CR11
IN5234
6.2V
0.5W
R4
560
CR2
IN4002
CR4
IN4002
CR1
IN4002
CR3
IN4002
C1
2600
R14
3.3K
(NOTE 4)
Q1
2N3055
R1
68
R7
22
Q2
2N2105
C6
0.01
C4
2.7
R10
47K

1343538



NOTES:

1. ALL RESISTANCE IN OHMS, K=1000
2. ALL RESISTORS 1/2 W, ±5% UNLESS OTHERWISE STATED
3. ALL CAPACITANCE IN UF UNLESS OTHERWISE STATED
4. Q1 IS MOUNTED ON POWER SUPPLY ENCLOSURE AND IS SHOWN WITHIN P.C. BOARD A2 FOR FUNCTIONAL CLARITY ONLY

Figure 4-3. +28 V dc Regulated Power Supply A1A1 Schematic Diagram

voltage is rectified by CR10 and filtered by C1 with the resultant unregulated voltage (approximately 35 V) being applied to the collectors of series regulator drivers Q2 and Q3. This unregulated voltage is then clamped by CR5 (zener, 15 V), forming the constant-voltage source at the junction of CR5 and R1. The constant voltage source, in conjunction with R13, forms the controlled current supply to series regulator driver Q3 and supplies power to the constant current source circuitry (Q8, R2, CR6, and R18). The constant current source develops a stable voltage across CR7 (zener, 6.2 V) that is essentially independent of line and load variations. This voltage is divided by R3 and R4, and the resultant voltage, applied to the base of Q5, is the reference voltage for the voltage comparator circuit. There, it is compared to a voltage representative of the power supply output developed by R9, R15, R16, and R17, and applied to the base of Q6. CR12 protects the base of Q6 from becoming excessively negative with respect to the base of Q5. External load variations result in changes in the -OUT voltage, as the +OUT is in series with both the bias supply and the reference voltage on the base of Q5. As the power supply voltage increases (-OUT going more negative), Q6 conducts more heavily, increasing the current through R14 and R21, and increasing conduction through Q7. Increased conduction through Q7 shunts current away from Q3, causing the series regulators to conduct less, thus lowering the output voltage (-OUT going more positive). Overload protection is provided by the current-sensing circuitry and current-sensing amplifier circuitry, consisting of R7, R10, R11, R12, CR9, CR11, C6, and Q4. During overload conditions, the voltage drop across R7 exceeds the forward bias threshold of CR9 and the base-to-emitter junction of Q4, causing Q4 to conduct, and reverse biasing CR9, which allows C6 to discharge. As C6 discharges, Q4 shunts current away from Q3, which lowers the power supply output voltage to a fraction of normal output. Then Q4 approaches a steady state of conduction which maintains the low output until the overload is removed. Since the internal regulating circuitry receives operational current from the constant voltage and constant current supplies, the regulating circuitry can function even in the event of a complete +OUT to -OUT short circuit. The series regulators, Q9 through Q14, are in a parallel configuration, using resistance wire for series resistors R25 through R28, R30, and R31 to compensate for small transistor-gain differences. R23, C7, and CR8 shunt +OUT to -OUT, providing a small constant load (R23), enhanced output impedance characteristics (C7), and protection against the application of a reversed voltage to the output taps (CR8).

4-9. -15 V DC REGULATED POWER SUPPLY A1A3. (See figures 4-6 and 4-7.) This constant voltage/current-limiting power supply provides -15 V dc at 5 amperes to various MFR circuits, and is electrically configured in series with the +15 V dc power supply for some of the MFR circuits. Due to this configuration, these two power supplies can resist the turn-on of each other or of themselves. The -15 V dc power supply consists of the following circuits: a fuse-protected ac input circuit and transformer; a full-wave rectifier and filter circuit; a Darlington-configured series regulator and driver circuit; a μA723 precision voltage regulator integrated circuit containing temperature-compensated reference voltage circuitry, voltage comparator circuitry, and current-limiting circuitry; a voltage regulator output amplifier (pass transistor); and an overvoltage protection (crowbar) circuit. (See figure 4-6.) The series regulator driver receives base current through the voltage regulator amplifier, which is controlled by the precision voltage regulator integrated circuit. The precision voltage regulator integrated circuit output is a function of the inputs to the voltage comparator circuits, but control of the output is assumed by the current-limiting circuit during overload conditions. The overvoltage protection circuit trips at a preset overvoltage, applies a short circuit to the output taps, and can be reset only by removing ac power to the power supply.

4-10. An ac voltage is applied to transformer T1 through fuse F1 with filter C1 across the inputs to remove line spikes. The output of T1, filtered by C2 to remove any remaining line spikes is rectified by CR1 through CR4 and filtered by C3 and R1. The positive dc output is applied to the precision voltage regulator integrated circuit

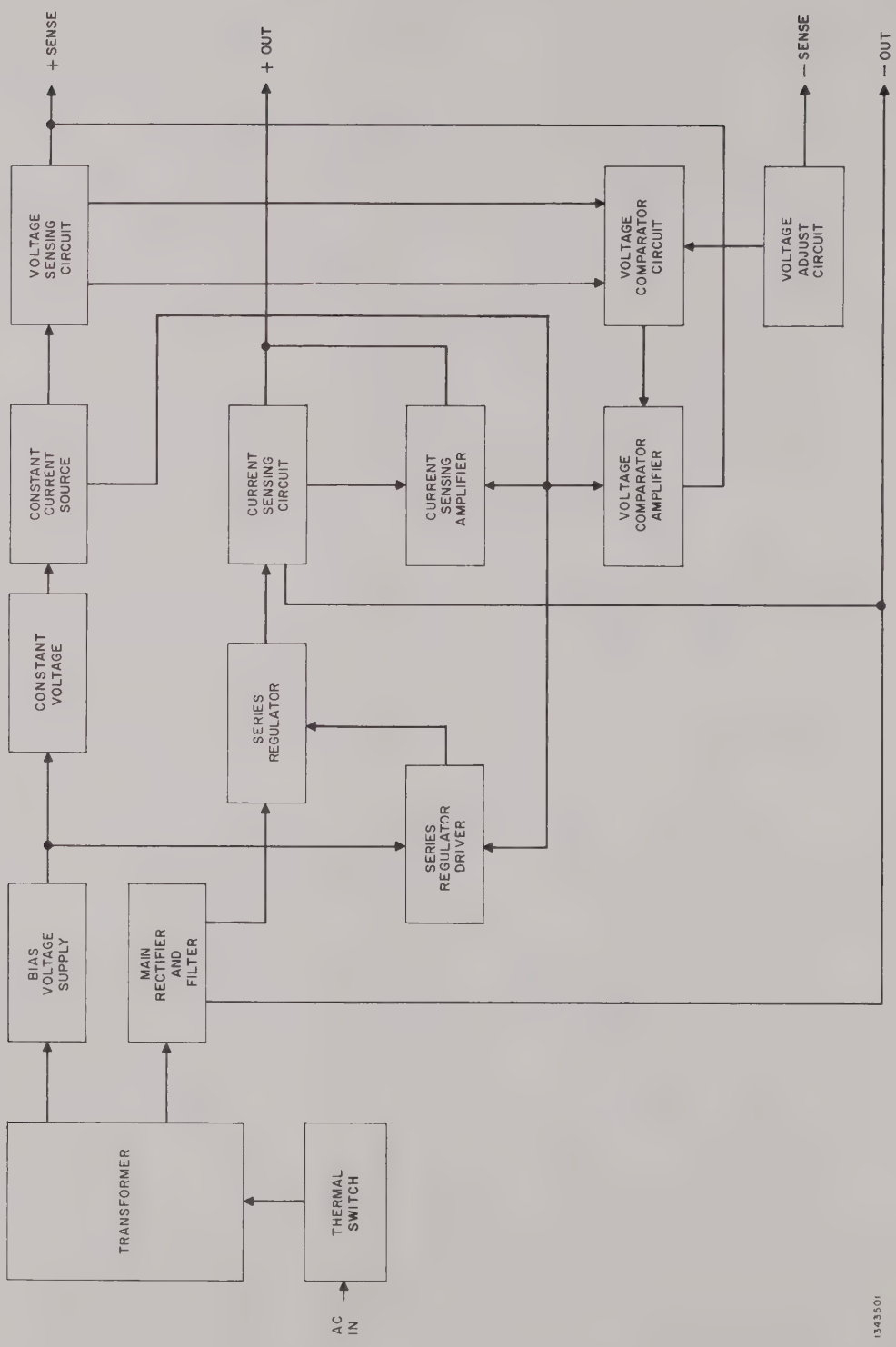
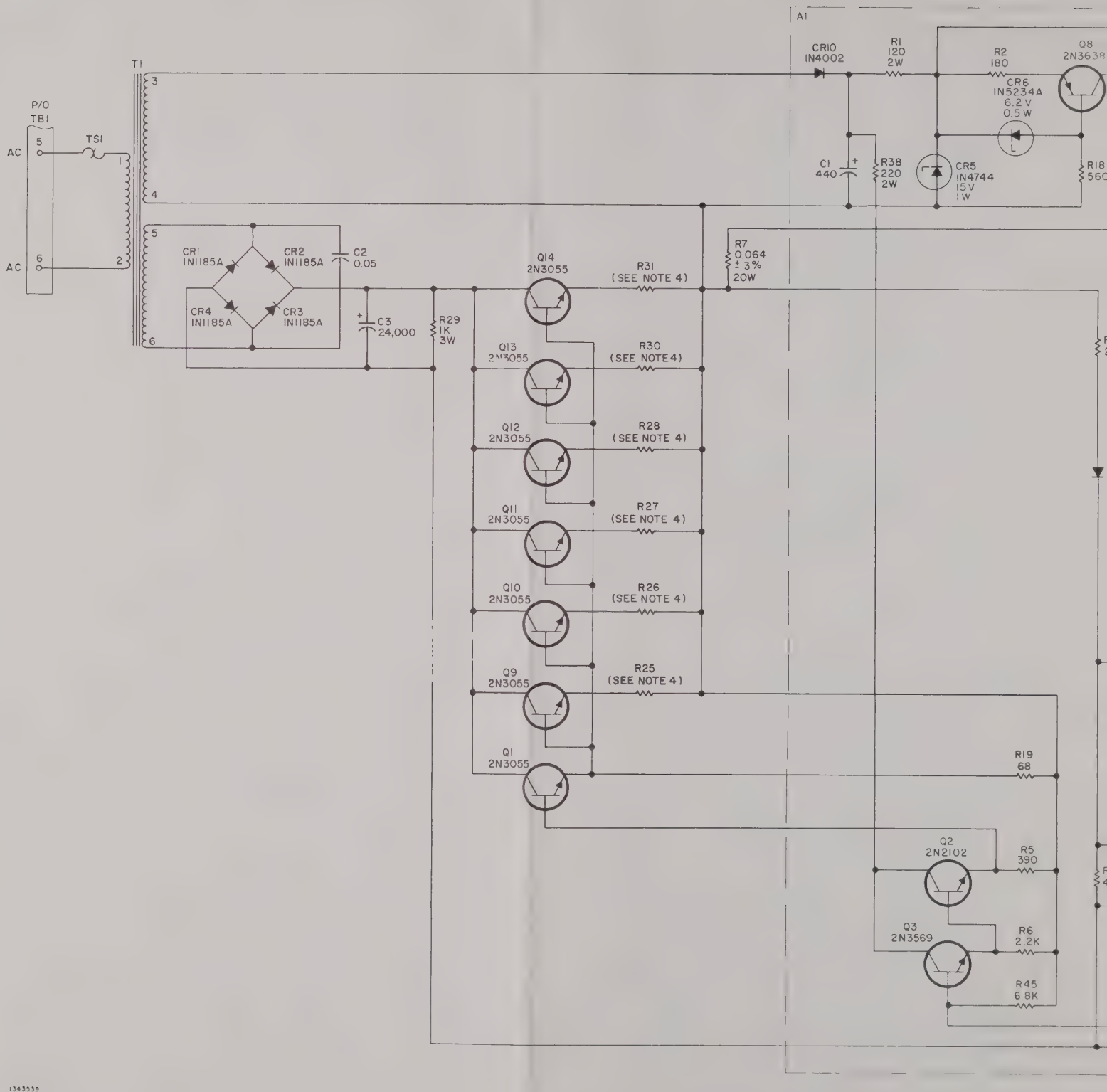
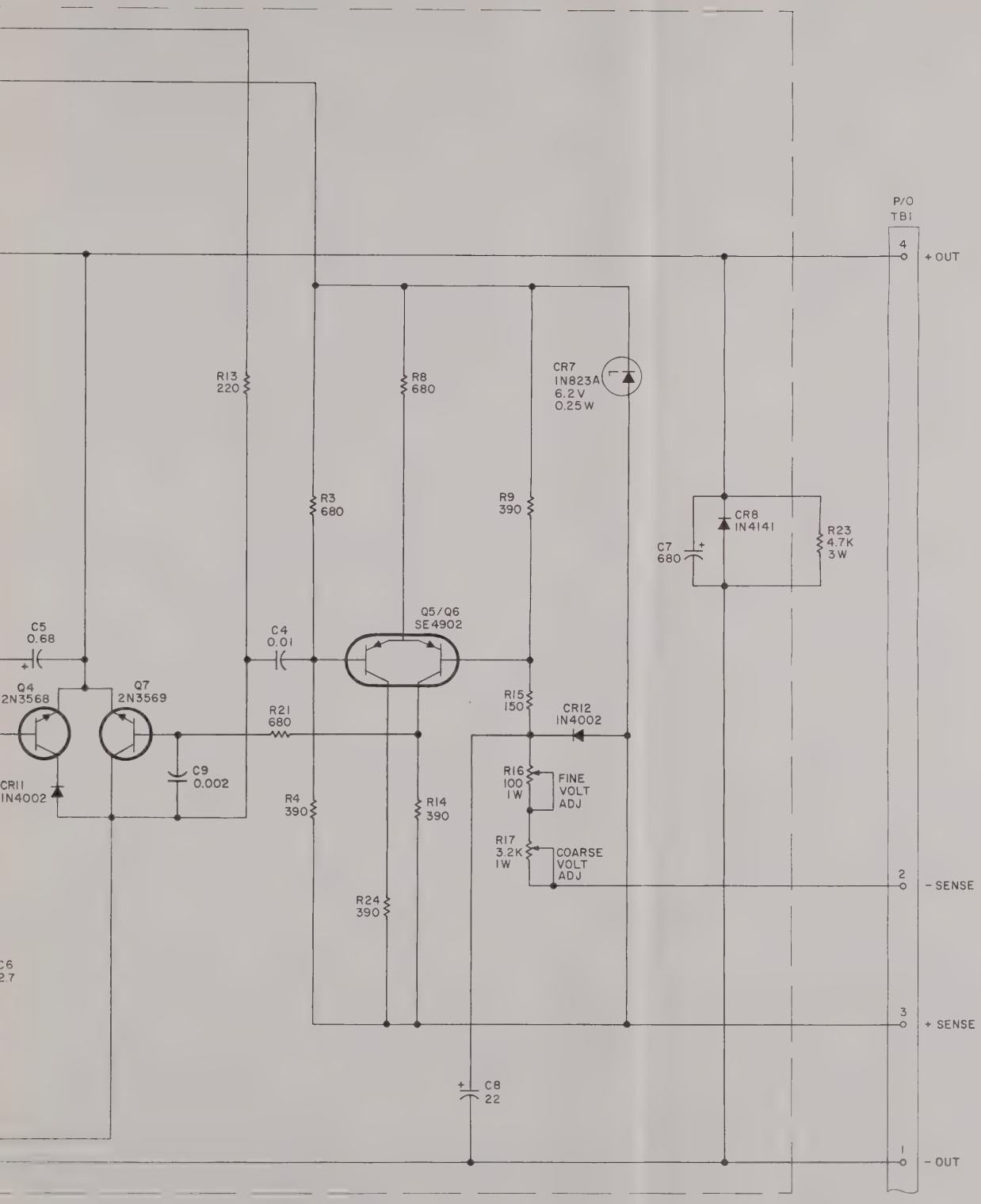


Figure 4–4. +15 V dc Regulated Power Supply A1A2 Block Diagram


A1
P/O TB1
AC
5
6
TS1
T1
1
2
3
4
5
6
CR1 IN1185A
CR2 IN1185A
CR3 IN1185A
CR4 IN1185A
C2 0.05
C3 24,000
R29 1K 3W
CR10 IN4002
R1 120 2W
R2 180
Q8 2N3638
CR6 IN5234A 6.2 V 0.5 W
L
C1 440
R38 220 2W
CR5 IN4744 15V 1W
R18 560
R7 0.064 ± 3% 20W
Q14 2N3055
R31 (SEE NOTE 4)
Q13 2N3055
R30 (SEE NOTE 4)
Q12 2N3055
R28 (SEE NOTE 4)
Q11 2N3055
R27 (SEE NOTE 4)
Q10 2N3055
R26 (SEE NOTE 4)
Q9 2N3055
R25 (SEE NOTE 4)
Q1 2N3055
R19 68
Q2 2N2102
R5 390
Q3 2N3569
R6 2.2K
R45 6.8K

1343539



NOTES:

1. ALL RESISTANCE IN OHMS; K=1000
2. ALL RESISTORS ± 5%, 1/2 W, UNLESS OTHERWISE STATED
3. ALL CAPACITANCE IN UF UNLESS OTHERWISE STATED
4. R25, R26, R27, R28, R30, R31 ARE 2-INCH LENGTHS OF RESISTANCE WIRE

Figure 4–5. +15 V dc Regulated Power Supply A1A2 Schematic Diagram

U1, to the precision voltage regulator output amplifier Q5, to the series regulators Q2, Q3, and Q4, and to driver Q1. R2, the emitter resistor for emitter follower driver Q1, also functions as the current monitoring resistor. R3, R4, and R5, emitter resistors for Q2, Q3, and Q4, are 0.1 ohm, 2-inch lengths of resistance wire that balance small gain differentials in the series regulators. The series regulator circuit output of U1 through the +SENSE tap (externally connected to +OUT) after voltage division by R15, R16 (output voltage fine adjust), and R27. Pin 4 of U1 is compared to pin 5 (noninverting input), which is fixed at 5.1 V dc by clamping the temperature-compensated reference voltage (pin 6) with CR6 (zener, 5.1 V), resulting in a very stable reference. The current into pin 4 fluctuates as a function of the output voltage, and this fluctuation results in a current change at pin 11 (Vc) and pin 10 (Vout). As the power supply load decreases, the output voltage rises, the voltage at pin 4 rises, and the current through pin 10 and pin 11 decreases, causing less current at the base of Q5. Q5 supplies less current to the base of Q1, resulting in less conduction by Q1, Q2, Q3, and Q4. As the power supply load increases, the reverse of the preceding sequence occurs until an overload condition is reached. An overload causes the voltage drop across R2 to exceed the inherent forward bias threshold of the current-limiting circuit in U1, resulting in conduction of the current-limiting circuit which shunts current away from pin 11. The current-limiting circuit can shunt sufficient current away from Q5 to reduce conduction of the series regulators to produce a fraction of normal power supply output. The power supply remains in this state until the overload is removed. The current-limiting circuit also provides a coarse output adjustment (R10) by changing the bias on pin 2, which results in shunting of a small fixed current away from pin 11. Overvoltage protection is provided by a silicon controlled rectifier (SCR) circuit, consisting primarily of active elements SCR1, Q6, and Q7 with a thermal compensating resistor RT1. R20 is adjusted to provide a base bias on Q7 so that Q7 conducts when the voltage across R19, R20, R21, and R22/RT1 exceeds the preselected voltage (greater than 15 V). Conduction by Q7 causes conduction through R17 and R18, causing Q6 to conduct, which, utilizing R23 as a feedback path to the base of Q7, reinforces conduction of Q7, and results in a rapid saturation of both Q6 and Q7. This results in the application of a gate voltage to SCR1 through R24, and conduction by SCR1. SCR1 conduction shunts the +OUT tap, forcing the current-limiting circuitry to reduce series regulator conduction. The SCR continues to conduct until ac power is removed from the power supply. Fuse F2 protects the series regulator circuit in the event the current-limiting circuit should fail. R26, C10, and CR10 shunt +OUT to -OUT, providing a small constant load (R26), enhanced output impedance characteristics (C10), and protection against the application of a reversed voltage to the output taps (CR10).

4-11. INTERACTION OF +15 V AND -15 V POWER SUPPLIES DURING TURN-ON. Since the +15 V and -15 V power supplies operate in a series configuration, difficulties may be encountered during the turn-on of power supply drawer A1. If, during turn-on, the regulation circuitry of the two power supplies responds to the combined load requirement at different time-frame rates, the -15 V power supply overvoltage protection circuit can be activated. When activated, the -15 V power supply output is 0 V, the series output of the two power supplies is 15 V instead of the required 30 V, and the POWER lamp (DS2) is dimly lighted due to the reduced operating voltage. Since the overvoltage protection circuit can be reset only by removing ac power to the power supply, the power supply drawer A1 POWER ON circuit breaker (CB1) must be cycled to OFF, then back to ON. Tripping of the overvoltage protection circuit is considered a normal occurrence during turn-on and is not necessarily indicative of a malfunctioning power supply. However, excessive turn-on difficulties would indicate a verification of the preselected overvoltage trip level (R20 adjusted for a trip voltage of 16.5 V to 17.0 V).

4-12. +5.5 V DC REGULATED POWER SUPPLY A1A4. (See figures 4-8 and 4-9.) This constant voltage/current limiting power supply provides +5.5 V dc at 5 amp to various MFR circuits. The +5.5 V dc power

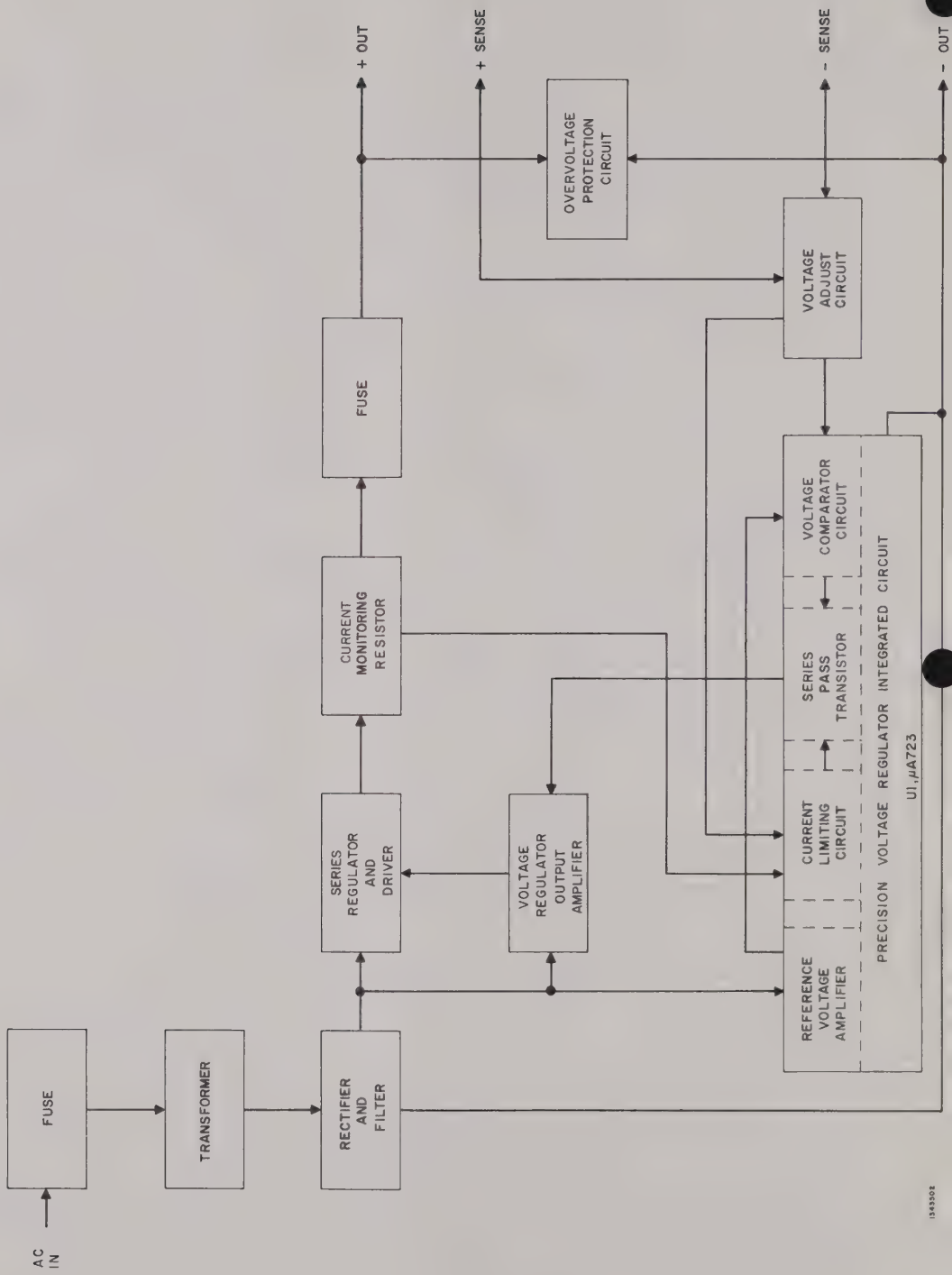
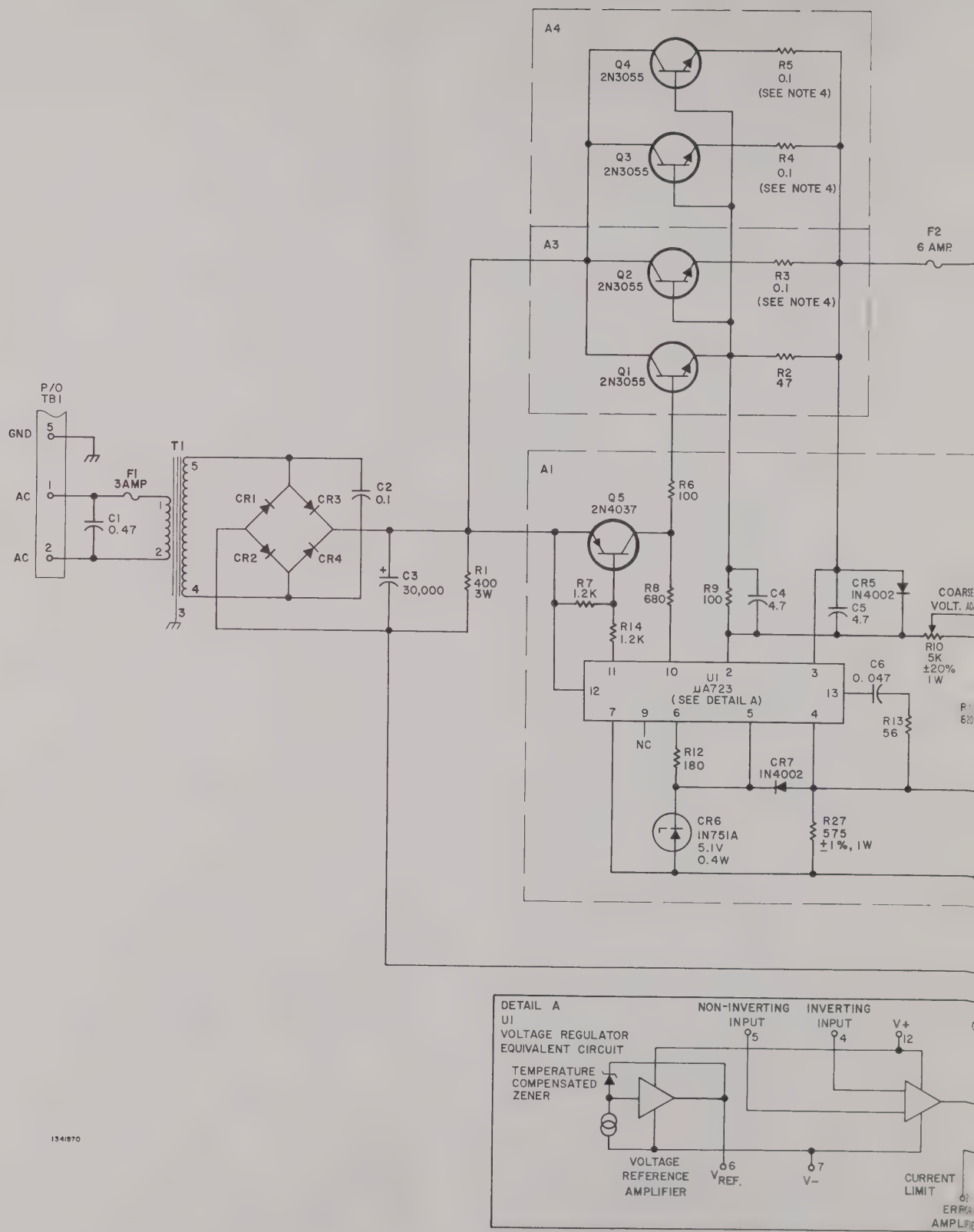
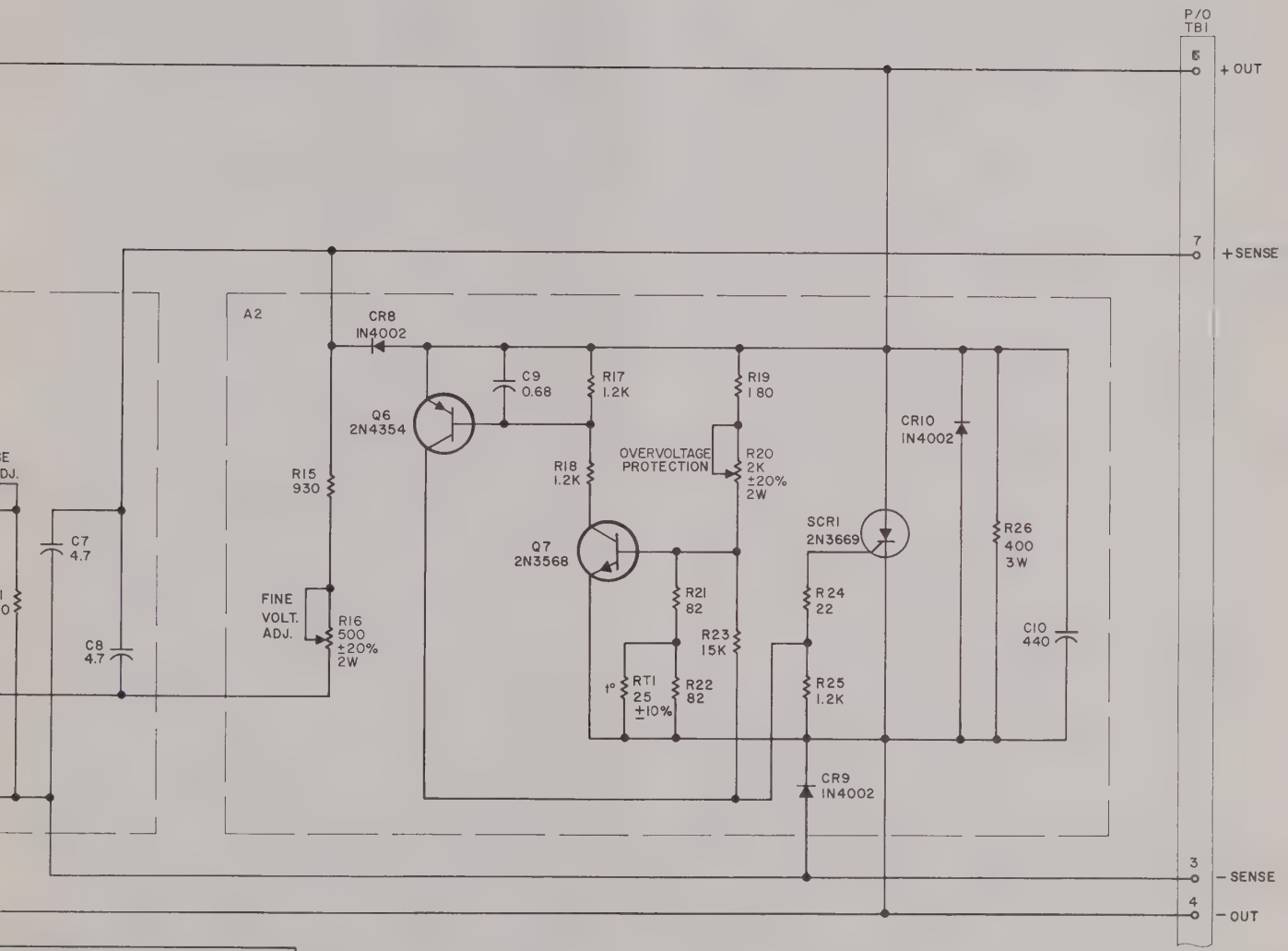
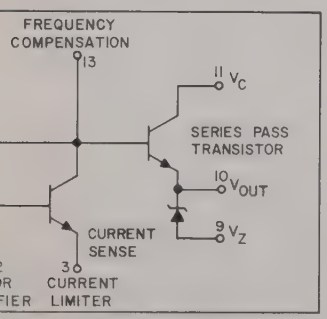


Figure 4–6. −15 V dc Regulated Power Supply A1A3 Block Diagram


A4
Q4
2N3055
R5
0.1
(SEE NOTE 4)
Q3
2N3055
R4
0.1
(SEE NOTE 4)
A3
F2
6 AMP
Q2
2N3055
R3
0.1
(SEE NOTE 4)
Q1
2N3055
R2
47
P/O
TB1
GND
5
AC
1
AC
2
F1
3AMP
C1
0.47
T1
5
1
2
4
3
CR1
CR3
CR2
CR4
C2
0.1
C3
30,000
R1
400
3W
A1
Q5
2N4037
R6
100
R7
1.2K
R8
680
R9
100
C4
4.7
CR5
IN4002
C5
4.7
COARSE
VOLT. AD
R10
5K
±20%
1W
R14
1.2K
11
10
U1
2
3
12
μA723
(SEE DETAIL A)
13
C6
0.047
7
9
6
5
4
R13
56
NC
R12
180
CR7
IN4002
CR6
IN751A
5.1V
0.4W
R27
575
±1%, 1W
DETAIL A
U1
VOLTAGE REGULATOR
EQUIVALENT CIRCUIT
NON-INVERTING
INPUT
5
INVERTING
INPUT
4
V+
12
TEMPERATURE
COMPENSATED
ZENER
VOLTAGE
REFERENCE
AMPLIFIER
6
VREF.
7
V−
CURRENT
LIMIT
ERR
AMPLIF
1341870





NOTES:

1. ALL RESISTANCE IN OHMS, K=1000.
2. ALL RESISTORS 1/2 W, ±5% UNLESS OTHERWISE STATED.
3. ALL CAPACITANCE IN UF, UNLESS OTHERWISE STATED.
4. R3, R4, AND R5 ARE 2-INCH LENGTHS OF RESISTANCE WIRE.

Figure 4-7. −15 V dc Regulated Power Supply A1A3 Schematic Diagram

supply consists of the following circuits: an ac input circuit and transformer; a full-wave rectifier and filter generating a control voltage; a main supply full-wave rectifier and filter; a Darlington-configured series regulator and driver circuit; a μA723 precision voltage regulator integrated circuit containing temperature-compensated reference voltage circuitry, voltage comparator circuitry, and current-limiting circuitry; and an overvoltage protection (crowbar) circuit. Referring to figure 4-8, the series regulator driver receives base current from the main supply rectifier through the precision voltage regulator integrated circuit. The output of the precision voltage regulator integrated circuit is normally a function of the inputs to the voltage comparator circuit except when an overload condition occurs. During overload periods, the current-limiting circuitry controls the current output. The overvoltage protection circuit trips at a preset output voltage level, applies a short circuit to the power supply output taps, and can be reset only by removing ac power to the power supply.

4-13. An ac input voltage is applied to transformer T1. The single T1 output winding is utilized to produce two voltages: a stable control voltage rectified by CR3 and CR4 and filtered by C2, and the main supply voltage rectified by CR1 and CR2 and filtered by C1 and R1. The approximate resultant voltages are 28 V dc (control) and 14 V dc (main supply). The control voltage is connected to pin 12 (Vc) of the precision voltage regulator integrated circuit U1 where a temperature-compensated reference voltage results at pin 6. This very stable reference voltage, after voltage division by R11, R12, and R13 (output voltage adjust) is applied to pin 5 (noninverting input), and is utilized by the voltage comparator circuit. To derive a controlled series regulator driver base current, the +SENSE voltage (externally connected to +OUT) is applied to pin 4 of U1, is compared to the pin 5 reference voltage, and the resulting differential current controls the U1 internal pass transistor circuit outputting on pin 10 (Vout). Pin 10 of U1 drives series regulator driver Q1, which drives series regulators Q2, Q3, and Q4. In the series regulator and driver circuit, R2 maintains base bias on Q1, R3 maintains emitter bias, and R4, R5, and R6 balance out minor gain differentials in series regulators Q2, Q3, and Q4. During normal load range operation, a decrease in the power supply load results in an increased output voltage, higher voltage at pin 4, and decreased current through pin 10 (Vout). Less current (thus lower voltage) at pin 10 lowers conduction through Q1, and through Q2, Q3, and Q4, which lowers the output voltage. An increase in the power supply load results in a reverse of the preceding sequence until an overload condition occurs. An overload condition develops when the voltage drop across R7 (current monitoring resistor) exceeds the forward bias threshold of CR5 and the current-limiting circuitry of U1 (pin 2 and pin 3). Since pin 3 is the emitter and pin 2 is the base of a shunt transistor in U1, as the voltage across R7 exceeds the forward bias thresholds of CR5 and the shunt transistor, the shunt transistor conducts with the initial conduction accelerated by the discharging of C3 through R8. This internal U1 shunt transistor shunts current away from the internal pass transistor circuit, decreasing the current through pin 10 (Vout) and therefore decreasing conduction through the series regulator circuit to a fraction of normal power. The power supply output remains fractional until the overload is removed. Overvoltage protection is provided by a silicon controlled rectifier (SCR) circuit, consisting primarily of active elements SCR1, Q5, and Q6, and with a thermal compensating resistor RT1. R17 is adjusted to provide a base bias on Q6 so that Q6 conducts when the voltage across R16, R17, R18, and R20/RT1 exceeds the preselected trip voltage (greater than 5.5 V). (RT1 changes resistance as a function of ambient temperature, thus changing the bias on Q6 to inhibit false triggering of Q6 by Q5 leakage current.) When the output voltage exceeds the preselected trip voltage setting, Q6 conducts, causing Q5 to conduct. Q5 conduction reinforces conduction of Q6, and applies a gate voltage to SCR1, causing SCR1 to conduct. SCR1 conduction shunts the +OUT tap to the -OUT tap, forcing the current-limiting circuitry to reduce series regulator conduction. The SCR continues to conduct until ac power is removed from the power supply. Fuse F1 protects the

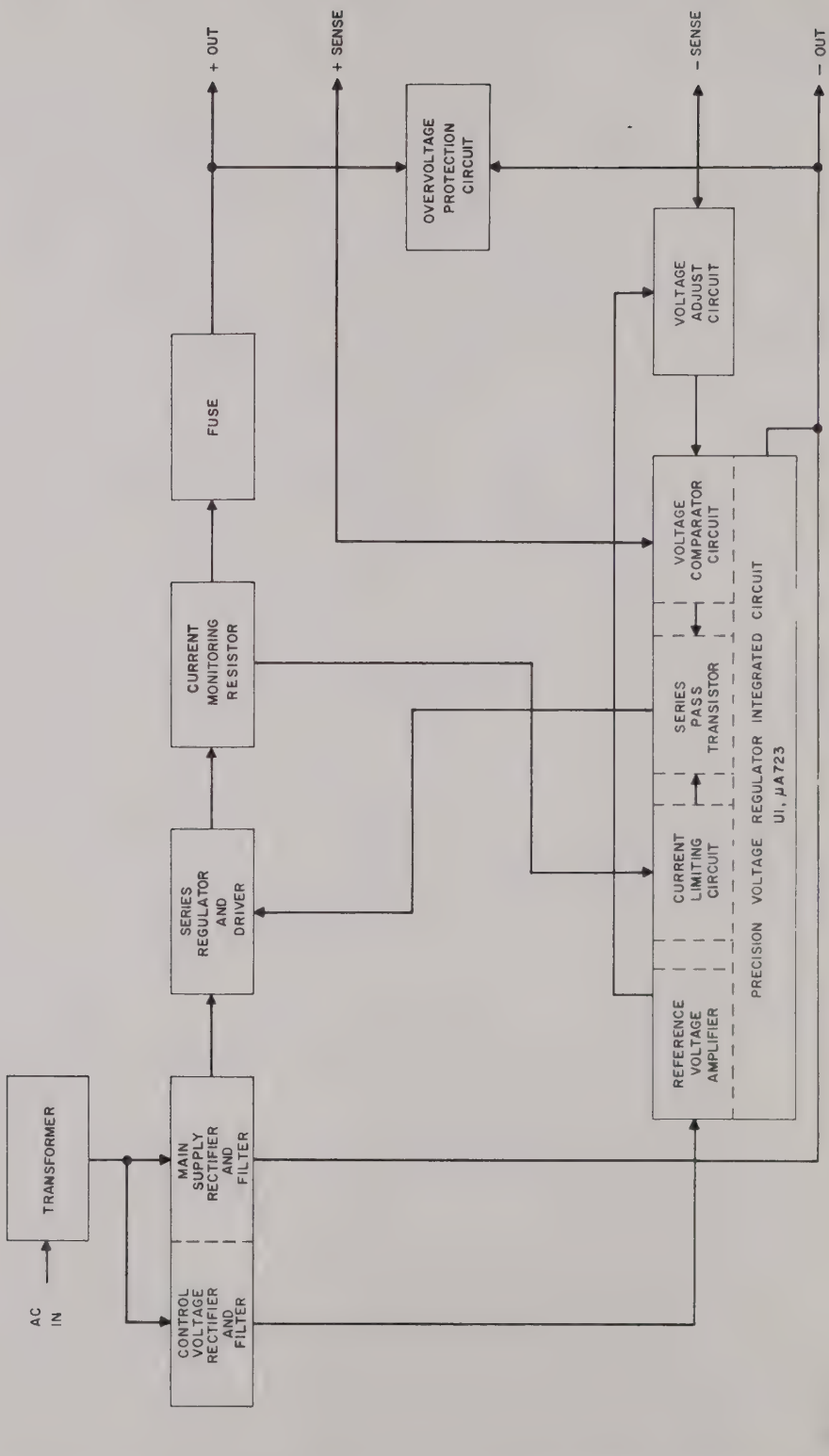
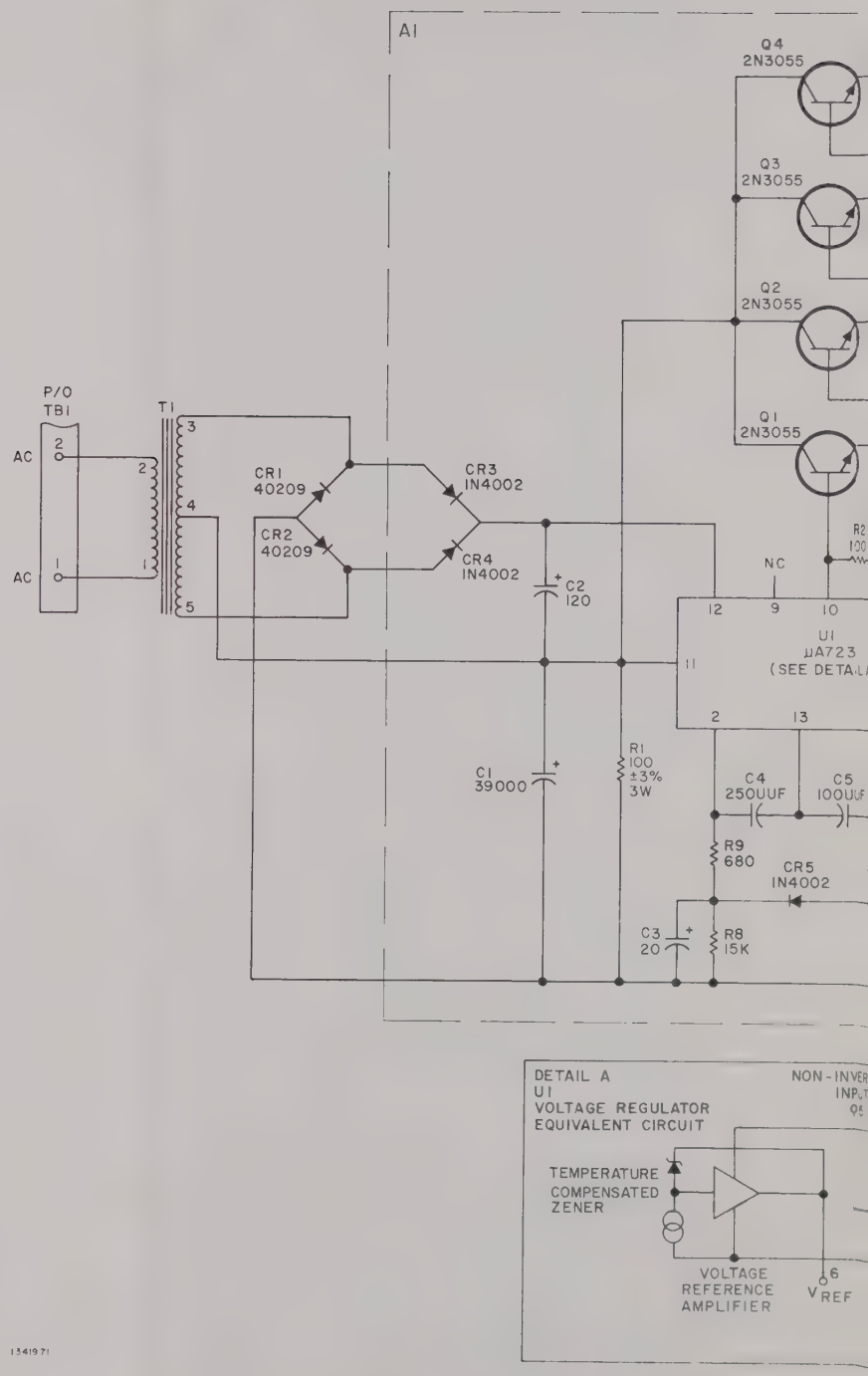
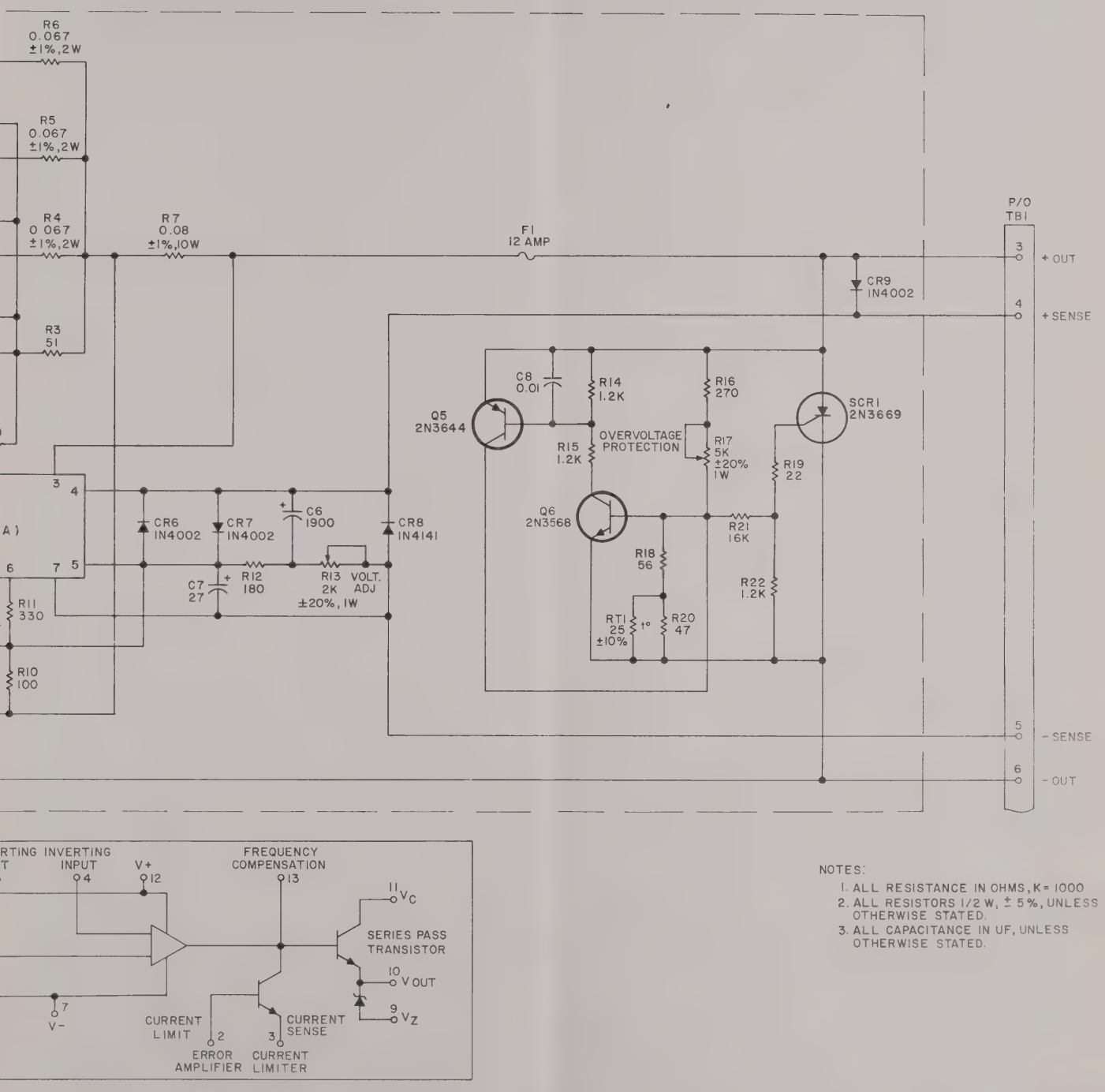


Figure 4–8. –5.5 V dc Regulated Power Supply A1A4 Block Diagram


A1
Q4
2N3055
Q3
2N3055
Q2
2N3055
Q1
2N3055
P/O
TB1
T1
AC
AC
CR1
40209
CR2
40209
CR3
IN4002
CR4
IN4002
C2
120
NC
12
9
10
U1
μA723
11
2
13
C1
39000
R1
100
±3%
3W
C4
250UUF
C5
100UUF
R9
680
CR5
IN4002
C3
20
R8
15K
DETAIL A
U1
VOLTAGE REGULATOR
EQUIVALENT CIRCUIT
TEMPERATURE
COMPENSATED
ZENER
VOLTAGE
REFERENCE
AMPLIFIER
6
VREF

13419 71

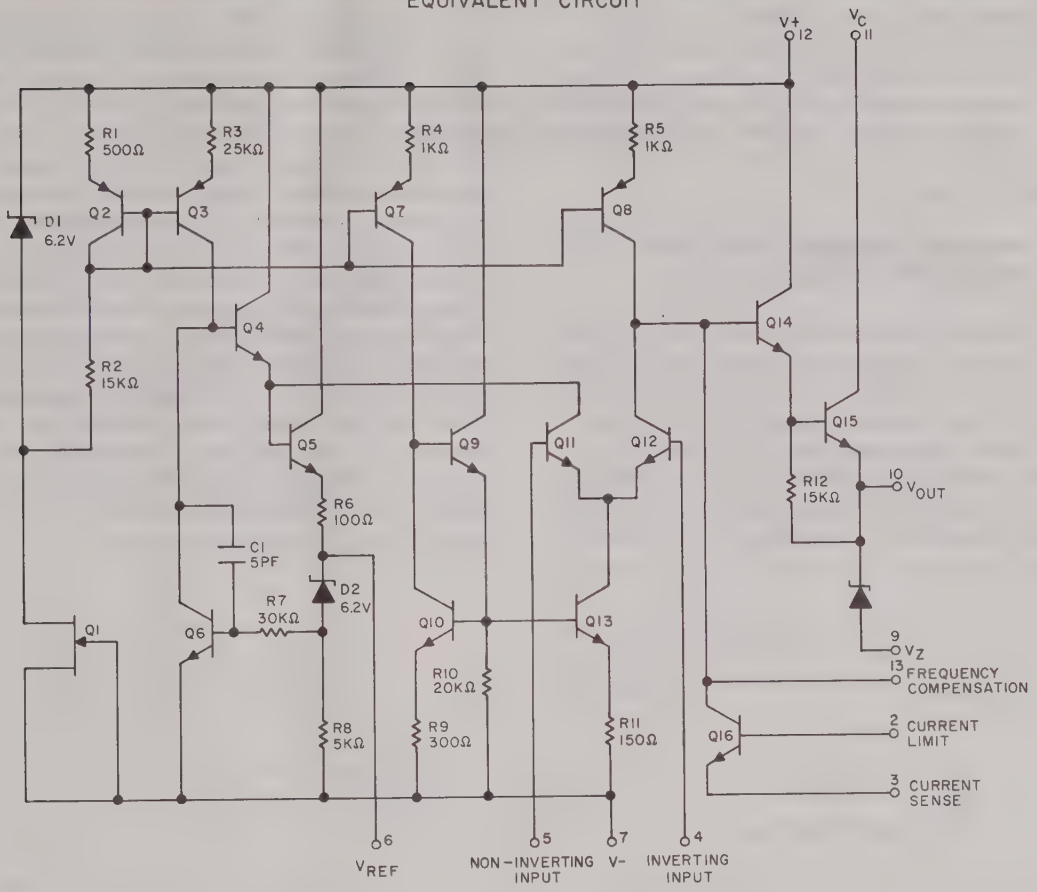


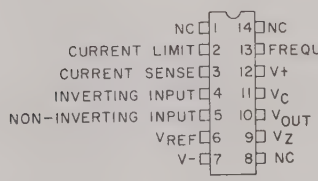
NOTES:

1. ALL RESISTANCE IN OHMS, K = 1000
2. ALL RESISTORS 1/2 W, ± 5%, UNLESS OTHERWISE STATED.
3. ALL CAPACITANCE IN UF, UNLESS OTHERWISE STATED.

Figure 4–9. +5.5 V dc Regulated Power Supply A1A4 Schematic Diagram

EQUIVALENT CIRCUIT




NC 1 14 NC
CURRENT LIMIT 2 13 FREQUENCY COMPENSATION
CURRENT SENSE 3 12 V+
INVERTING INPUT 4 11 VC
NON-INVERTING INPUT 5 10 VOUT
VREF 6 9 VZ
V- 7 8 NC

14 LEAD DIP
(TOP VIEW)
U6A7723393

ABSOLUTE MAXIMUM RATINGS

PULSE VOLTAGE FROM V+ TO V- (50MS) (312 GRADE)	50V
CONTINUOUS VOLTAGE FROM V+ TO V-	40V
INPUT-OUTPUT VOLTAGE DIFFERENTIAL	40V
DIFFERENTIAL INPUT VOLTAGE	±5V
VOLTAGE BETWEEN NON-INVERTING INPUT AND V-	+8V
CURRENT FROM VZ	25MA
CURRENT FROM VREF	15MA
INTERNAL POWER DISSIPATION	1000MW
STORAGE TEMPERATURE RANGE	-65°C TO +150°C
OPERATING TEMPERATURE RANGE	0°C TO +70°C
LEAD TEMPERATURE (SOLDERING, 60 SECONDS)	300°C

1343568

Figure 4–10. Equivalent Circuit, Lead Configuration, and Maximum Ratings of μA723

series regulator circuit in the event of current-limiting circuitry failure. CR6 and CR7 protect the inverting and noninverting inputs to U1 by limiting the voltage differential between pins 4 and 5 to plus or minus 0.5 V. CR8 prevents -SENSE from becoming more positive than +SENSE, and CR9 clamps +SENSE to +OUT.

4-14. PRECISION VOLTAGE REGULATOR INTEGRATED CIRCUIT (μA723).

4-15. The μA723 precision voltage regulator integrated circuit is a monolithic voltage regulator constructed on a single silicon chip. The unit used in the -15 V and the +5.5 V power supplies is a U6A7723393 ceramic dual inline package (DIP). Referring to the equivalent circuit (figure 4-10), a voltage applied to V^+ (above 12 V) results in a very stable reference voltage of approximately 7.2 V at pin 6. A voltage applied to Vc becomes the collector voltage for Q15, which is controlled by common-emitter voltage comparators Q11/Q12, current shunt amplifier Q16, and driver Q14. Differential voltages applied to the inverting and noninverting inputs result in variations in current through Q12 which shunts base current away from Q14. Likewise, conduction by Q16 shunts current away from the base of Q14. These two shunt circuits control the gain of Q14 and, therefore, Q15. In the 5.5 V power supply, the emitter of Q15 (Vout) directly drives the series regulator driver transistor. In the -15 V power supply an external pass transistor is employed to obtain sufficient current to adequately drive the series regulator driver transistor.

SECTION V
MAINTENANCE

5-1. GENERAL.

5-2. This section provides instructions for preventive maintenance, and instructions and technical aids for corrective maintenance to maintain and repair the four regulated power supplies included in the MFR Power Supply Drawer A1.

WARNING

Removal of power supply terminal covers and/or the bottom cover of the MFR Power Supply Drawer A1 will expose dangerous potentials of 120 volts ac and/or 200 volts dc. Use extreme caution when working with the covers removed. Remove power prior to removing or replacing covers.

5-3. PREVENTIVE MAINTENANCE.

5-4. Preventive maintenance is performed on the MFR Power Supply Drawer A1 as an integral part of the MFR, and is beyond the scope of this manual. Preventive maintenance procedures for the MFR are defined by applicable publication listed in table 1-1.

5-5. CORRECTIVE MAINTENANCE.

5-6. (See figure 5-1 for power supply locations.) Corrective maintenance procedures are provided in the following formats: a set of general guidelines and procedures applicable to all four regulated power supplies; troubleshooting guides tailored to each individual power supply; voltage charts for each power supply; and minimum performance standards for each power supply.

5-7. GENERAL GUIDELINES AND PROCEDURES. Prior to removing a suspect power supply from the power supply drawer, perform the following checks with a volt-ohm-meter. Verify presence of 120 V ac between test points TP7 and TP8 (see figure 3-2), and check fuses F1 and F2. Referring to figure 7-1, these verifications indicate ac power should be present at the ac inputs of all power supplies. If ac power is not present, check operation of circuit breaker CB1 and contacts J4-1 and J4-2 of power plug J4. Next, remove jacks J1, J2, and J3, and check suspect power supply's output after recycling POWER ON switch. The above check, if verified, indicates a problem external to the power supply drawer. If the problem persists, remove the terminal cover of the affected power supply and check for presence of correct ac and dc voltages.

WARNING

Removal of power supply terminal covers and/or the bottom cover of MFR Power Supply Drawer A1 will expose dangerous potentials of 120 volts ac and/or 200 volts dc. Use extreme caution when working with the covers removed. Remove power prior to removing or replacing covers.

During this check, J1, J2, and J3 should be disconnected. The preceding checks, plus a visual inspection of power supply drawer wiring and connections, should isolate the problem to either an external source, a drawer wiring malfunction, or a faulty power supply.

5-8. To repair a faulty power supply, remove the power supply from the drawer as follows:

a. Turn circuit breaker switch CB1 to OFF position.

b. Disconnect jacks J1, J2, J3, and J4.

c. Disconnect ground strap.

d. Remove power supply drawer from drawer slides and place on workbench.

e. Remove bottom drawer cover.

f. Attach temporary labels to each of the wires connected to the power supply terminal strip (after removing terminal cover if not removed in previous step).

g. Remove wires connected to power supply terminal strip.

h. Remove power supply by removing four 10-32 screws that attach power supply to drawer. These four screws are accessible only from the underside of the drawer.

Install power supply in test setup as shown in figure 5-2. Using the appropriate troubleshooting guide and voltage chart, verify power supply operation with respect to Section IV, Theory of Operation. The parts location illustrations (Section VI) will aid in disassembly and in locating components. Prior to turn-on, inspect for obvious problems such as blown fuses, loose or shorted components, defective wiring, etc. (An in-circuit semiconductor tester, similar to American Electronics Laboratories Model 259C, may be used to check semiconductors but not the integrated circuits.) Verify all voltage levels per the voltage chart.

Note

Do not assume that the problem has been found when one faulty component has been located. Due to the many feedback circuits inherent in a regulated power supply, a failed component can be a cause or an effect. Check all active components prior to restoring power.

After the completion of the required corrective maintenance, and after testing for applicable minimum performance standards, the power supply is reinstalled by following steps a. through h. above, in reverse order.

5-9. TROUBLESHOOTING GUIDES AND VOLTAGE CHARTS

5-10. Table 5-1 is a listing of troubleshooting guides and voltage chart tables and page numbers.

5-11. DISPOSITION OF REPLACED COMPONENTS.

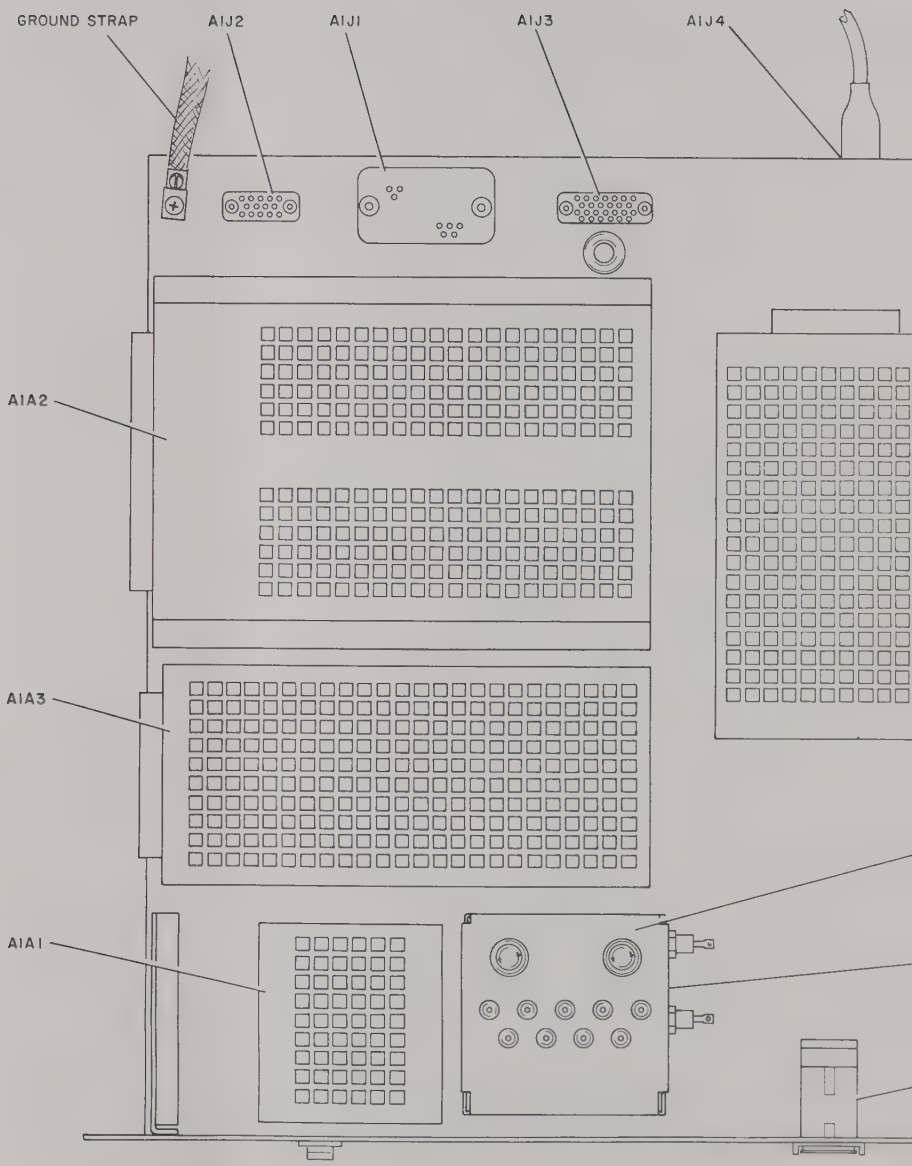
5-12. Components replaced during maintenance are to be disposed of according to the Network Logistics Manual, STDN No. 507.

5-13. MINIMUM PERFORMANCE STANDARDS.

5-14. Minimum performance standards are provided in table 5-10. Each performance standard can be readily identified by its bold print and clear box. (Information other than standards is located in shaded areas.)

Table 5-1. Troubleshooting Guides and Voltage Charts

POWER SUPPLY	TROUBLESHOOTING GUIDE		VOLTAGE CHART	
	TABLE	PAGE	TABLE	PAGE
A1A1 (+28 V dc)	5-2	5-6	5-3	5-6
A1A2 (+15 V dc)	5-4	5-7	5-5	5-8
A1A3 (-15 V dc)	5-6	5-8	5-7	5-9
A1A4 (+5.5 V dc)	5-8	5-9	5-9	5-10



1341997

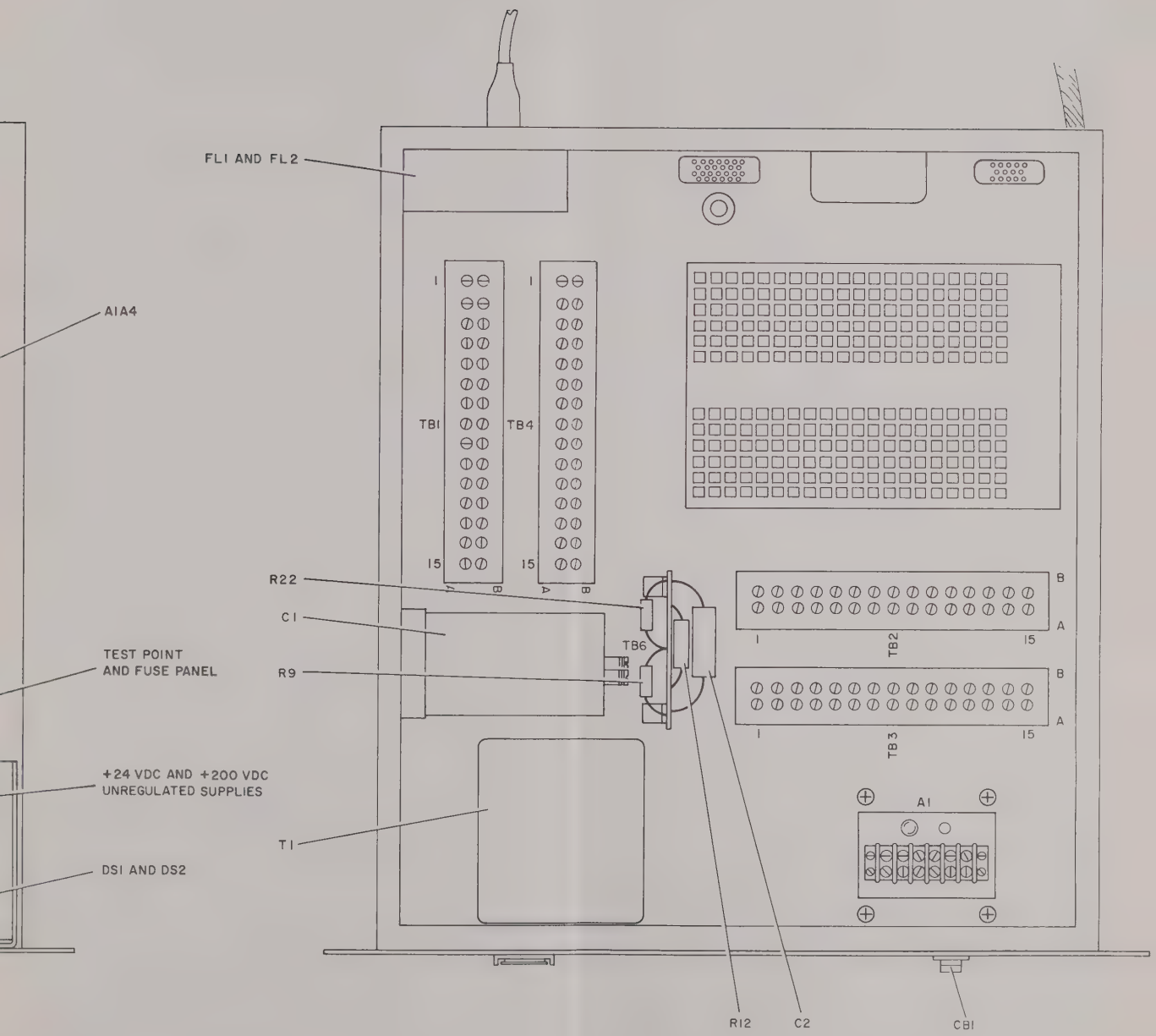


Figure 5–1. Location of Power Supply Drawer A1 Components

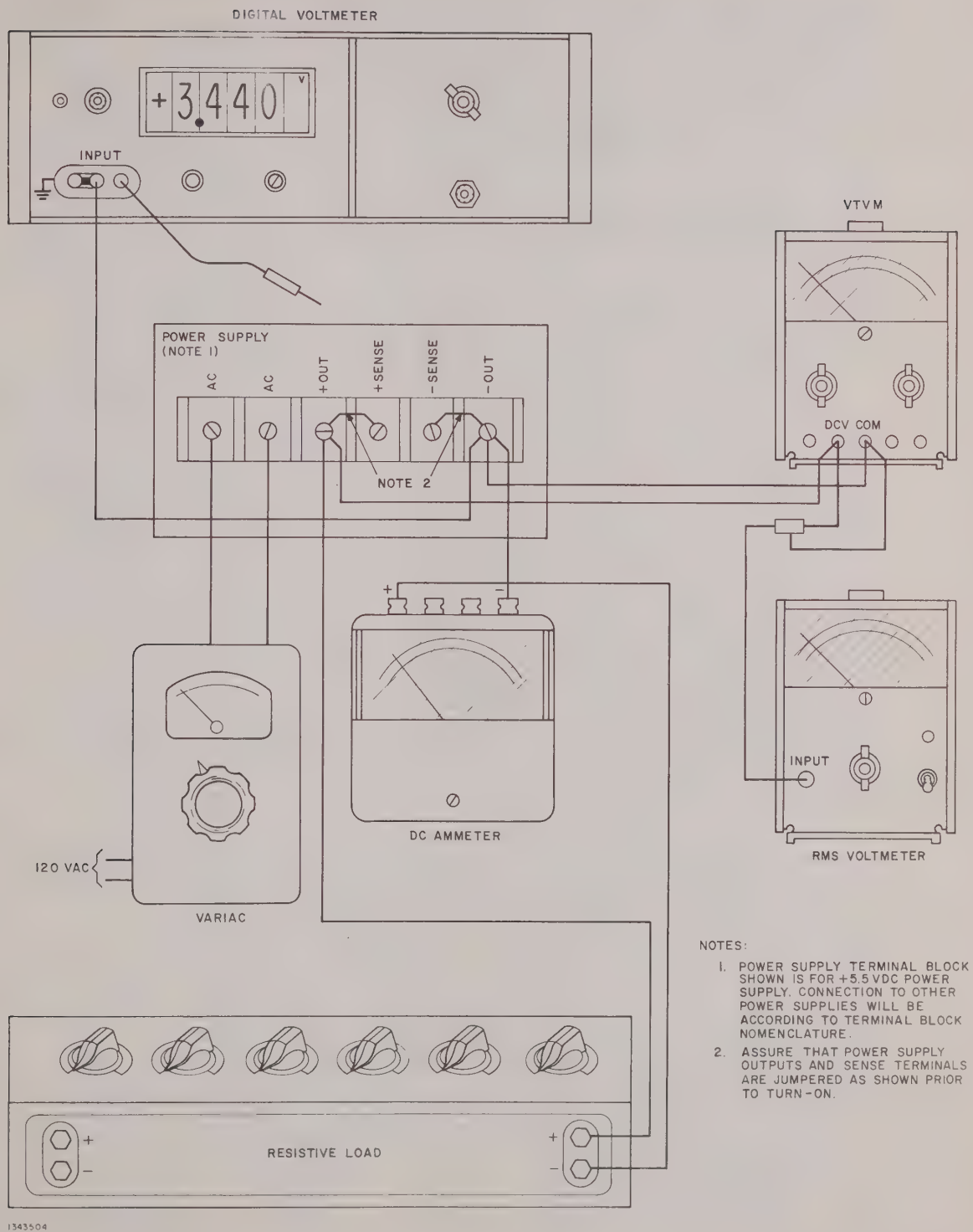


Figure 5-2. Test Connections for Monitoring Power Supply Voltage and Current

Table 5–2. +28 V dc (A1A1) Troubleshooting Guide

SYMPTOM	PROBABLE CAUSE	TEST
1. No output voltage	Open transformer winding Faulty bridge rectifier Faulty transistor Faulty zener diode Shorted C7 or CR15	Check winding continuity Check CR1 - CR4 Check all transistors Check CR11, CR12 Check for shorted condition
2. Unable to adjust output voltage	Faulty voltage adjust potentiometers Faulty Q5/Q6, C8, CR16	Check R17 and R18 for open condition Check junction of CR16, C8, R17, R19 while varying R17 or R18 Check base of Q6 for change while varying R17 or R18
3. Output voltage high	Q1, Q2, or Q8 shorted Q3 or Q4 open Q5/Q6 faulty CR11, CR12 faulty	Check for shorts. Use voltage chart Check for opens. Use voltage chart Check voltages on Q5/Q6 Check zener voltages
4. Output voltage low	Q5/Q6 faulty CR11, CR12 faulty CR13, CR16 shorted Q3, Q4 high leakage Q8 low conduction	Check voltages on Q5/Q6 Check zener voltages Check for shorts Check voltages per voltage chart Check voltages per voltage chart
5. High ripple, output not regulated	CR10, CR11, or CR12 open Shorted transistor	Check zener voltages Check all transistors
6. Improper current limiting	Faulty Q3, Q8	Check for shorts

Table 5–3. +28 V dc (A1A1) Voltage Chart

COMPONENT	COLLECTOR	BASE	EMITTER	ANODE	CATHODE
Q1	40.0	29.8	29.1		
Q2	40.0	30.4	29.8		
Q3	30.0	28.4	28.0		
Q4	30.4	28.6	28.0		
Q5	29.5	30.4	31.0		
Q6	28.6	30.4	31.0		
Q7	34.5	36.9	37.8		
CR6				AC	55.4
CR10				28.0	43.3

Table 5-3. +28 V dc (A1A1) Voltage Chart (Cont)

COMPONENT	COLLECTOR	BASE	EMITTER	ANODE	CATHODE
CR13				30.4	30.0
CR16				28.0	28.8

Notes:
1. All voltage readings taken with H-P Model 3440A Digital Voltmeter or equivalent.
2. All readings are referenced to minus output (minus lead connected to -OUT tap).
3. Power supply operating at 28.0 V, 0.25 A. Input: 120 V ac.
4. Readings may vary slightly due to component tolerances; however, the differential voltages between collector, base, and emitter for any one transistor should be constant.

Table 5-4. +15 V dc (A1A2) Troubleshooting Guide

SYMPTOM	PROBABLE CAUSE	TEST
1. No output voltage	Thermostat open	Check voltage across TS1
	Open T1 winding	Check winding continuity
	Faulty CR10, CR5, CR6 and/or CR7	Check for opens or shorts
	Faulty rectifier bridge	Check CR1 - CR4
	Shorted C7, CR8	Check for short
	Open Q1, Q2, Q3	Check for open
2. Unable to adjust output voltage	Faulty voltage adjust potentiometers	Check R16 and R17 for open conditions
	Faulty Q5/Q6, C8, CR16	Check junction of R15, R16, C8, CR12 while varying R16 or R17
		Check base of Q6 while varying R16 or R17
3. Output voltage high	Q1, Q2, or Q3 shorted	Check for shorts
	Q4, Q7 open	Check for open
	Q5/Q6 defective	Check voltages per voltage chart
	Faulty zener voltage	Check all zener diodes
4. Output voltage low	Open series regulator transistor(s)	Check Q9 - Q14
	Improper reference voltage	Check all zener voltages
	Q4, Q7 high leakage	Check voltages per voltage chart
5. High ripple, output not regulated	Open zener diode	Check all zener voltages
	Shorted series regulator circuit transistor	Check Q1-Q3, Q9-Q14 for shorts
	Faulty Q5/Q6	Check voltages per voltage chart
6. Improper current limiting	Faulty Q4	Check for short, low gain

Table 5-5. +15 V dc (A1A2) Voltage Chart

COMPONENT	COLLECTOR	BASE	EMITTER	ANODE	CATHODE
Q1	30.0	16.3	15.8		
Q2	49.8	17.0	16.3		
Q3	49.8	17.7	17.0		
Q4	16.9	14.5	15.0		
Q5	16.3	17.3	18.0		
Q6	15.6	17.3	18.0		
Q7	17.7	15.6	15.0		
Q8	21.4	23.8	24.5		
Q9-Q14	30.0	15.8	15.2		
CR5				15.2	30.2
CR10				AC	50

Notes: 1. All voltage readings taken with H-P Model 3440A Digital Voltmeter or equivalent.

2. All readings are referenced to minus output (minus lead connected to -OUT tap).

3. Power supply operating at 15.0 V, 2.0 A. Input: 120 V ac.

4. Readings may vary slightly due to component tolerances; however, the differential voltages between collector, base, and emitter for any one transistor should be constant.

Table 5-6. −15 V dc (A1A3) Troubleshooting Guide

SYMPTOM	PROBABLE CAUSE	TEST
1. No output voltage	Defective fuse Open TR1 winding Faulty rectifier bridge Open Q1, Q2 - Q4 SCR circuit firing or short-circuited	Check F1 and F2 Check winding continuity Check CR1 - CR4 Check for open circuits Check SCR1, Q6, Q7 for shorts, adjust R20 for minimum voltage on base of Q7
2. Unable to adjust output voltage	Defective U1 Faulty voltage adjust potentiometers	Check U1 voltages Check R10 and R16 for open condition
3. Output voltage high	Defective U1 Defective CR6 Shorted Q5, Q1, Q2 - Q4	Check U1 voltages Check CR6 for open Check for shorts

Table 5-6. −15 V dc (A1A3) Troubleshooting Guide (Cont)

SYMPTOM	PROBABLE CAUSE	TEST
4. Output voltage low	Defective U1	Check U1 voltages
	Defective CR5, CR6, CR7	Check for shorts or opens, check zener voltage of CR6
	Defective Q1, Q2, Q3, Q4 or Q5	Check for opens or low gain
5. High ripple output not regulating	Faulty rectifier bridge	Check CR1 - CR4
	Faulty series regulator	Check Q2 - Q4
	Open C3 or C10	Check operation of C3, C10

Table 5-7. −15 V dc (A1A3) Voltage Chart

COMPONENT	COLLECTOR	BASE	EMITTER	ANODE	CATHODE
Q1	26.0	16.3	15.8		
Q2-Q4	26.0	15.8	15.2		
Q5	16.3	25.4	26.0		
U1	Pin 1: Not used 2: 15.2 3: 15.0 4: 5.2 5: 5.2 6: 6.9 7: 0.0			Pin 8: Not used 9: Not used 10: 15.1 11: 24.8 12: 26.0 13: 16.4 14: Not used	

Notes:
1. All voltage readings taken with H-P Model 3440A Digital Voltmeter or equivalent.
2. All readings are referenced to minus output (minus lead connected to -OUT tap).
3. Power supply operating at 15 V, 2.0 A. Input: 120 V ac.
4. Readings may vary slightly due to component tolerances; however, the differential voltages between collector, base, and emitter for any one transistor should be constant.
5. Voltage readings for Q6, Q7, and SCR1 not included. During SCR1 conduction, Q6 and Q7 are in saturation state, SCR1 is short circuited.

Table 5-8. +5.5 V dc (A1A4) Troubleshooting Guide

SYMPTOM	PROBABLE CAUSE	TEST
1. No output voltage	No output power	Check F1
	SCR firing or SCR shorted	Check SCR1, Q5, Q6 for shorts
	Q1, Q2 through Q4 defective	Check Q1, Q2 through Q4 for shorts or opens
	U1 defective	Check U1 voltages

Table 5-8. +5.5 V dc (A1A4) Troubleshooting Guide (Cont)

SYMPTOM	PROBABLE CAUSE	TEST
2. Unable to adjust output voltage	CR6, CR7 defective U1 defective	Check CR6, CR7 for shorts Check U1 voltages
3. Output voltage too high	U1 defective Q1, Q2, Q3, Q4, CR6, CR7, CR8 defective	Check U1 voltages Check Q1, Q2, Q3, Q4, CR6, CR7, CR8 for shorts or opens
4. Output voltage too low	U1 defective Q1, Q2, Q3, Q4, CR5 defective	Check U1 voltages Check Q1, Q2, Q3, Q4, CR5 for shorts or opens
5. High ripple and unregulated output	Defective CR1 through CR4, C1, C2, U1	Check CR1 through CR4, C1, C4 for shorts or opens; check U1-pin 6 for stable voltage

Table 5-9. +5.5 V dc (A1A4) Voltage Chart

COMPONENT	COLLECTOR	BASE	EMITTER	ANODE	CATHODE
Q1	13.7	6.7	6.2		
Q2-Q4	13.7	6.2	5.6		
U1	Pin 1: Not used 2: 5.06 3: 5.50 4: 5.50 5: 5.50 6: 7.20 7: 0.0			Pin 8: Not used 9: Not used 10: 6.7 11: 13.7 12: 27.8 13: 8.05 14: Not used	

Notes:
1. All voltage readings taken with H-P Model 3440A Digital Voltmeter or equivalent.
2. All readings are referenced to minus output (minus lead connected to -OUT tap).
3. Power supply operating at 5.5 V, 2.0 A. Input: 120 V ac.
4. Readings may vary slightly due to component tolerances; however, the differential voltages between collector, base, and emitter for any one transistor should be constant.
5. Voltage readings for Q5, Q6, and SCR1 not included. During SCR1 conduction, Q5 and Q6 are in saturation state, SCR1 is short circuited.

Table 5–10. Minimum Performance Standards

POWER SUPPLY	MINIMUM PERFORMANCE TEST FOR	RESISTIVE LOAD SETTING	OUTPUT VOLTAGE		RIPPLE MONITOR (RMS)	REGULATION		COMMENTS
			ADJUST VARIABLE RESISTOR	VTVM READING (V dc)		CURRENT OUTPUT ±10%	VARIAC OUTPUT (V ac)	
A1A1	Voltage	100 ohms	R17	27 - 29			115	Coarse voltage adjust
(+28 V, 0.5 A)			R18	28 ±0.1 V		0.28 A		Fine voltage adjust
	Ripple				1 mV			Maximum ripple
	Regulation	100 ohms and 1100 ohms		28 ±0.1 V	1 mV	0.28 A and 0.025 A	105-125	Procedure 1
	Current limiting	56 ohms 55 ohms 54 ohms			1 mV 1 mV 1 mV	0.5 A 0.51 A 0.52 A	115	Procedure 2A
	Preoperational verification	100 ohms	R17, R18	28 ±0.1 V	1 mV	0.28 A	115	Procedure 3
A1A2	Voltage	3 ohms	R17	14.5 - 15.5			115	Coarse voltage adjust
(+15 V, 15 A)			R16	15 ±0.1 V		5.0 A		Fine voltage adjust
	Ripple				1 mV			Maximum ripple
	Regulation	3 ohms and 33 ohms		15 ±0.1 V	1 mV	5.0 A and 0.45 A	105-125	Procedure 1
	Current limiting							Procedure 2B
	Preoperational verification	3 ohms	R17, R16	15 ±0.1 V	1 mV	5.0 A	115	Procedure 3

Table 5-10. Minimum Performance Standards (Cont)

POWER SUPPLY	MINIMUM PERFORMANCE TEST FOR	RESISTIVE LOAD SETTING	OUTPUT VOLTAGE		RIPPLE MONITOR (RMS)	REGULATION		COMMENTS
			ADJUST VARIABLE RESISTOR	VTVM READING (V dc)		CURRENT OUTPUT ±10%	VARIAC OUTPUT (V ac)	
A1A3	Voltage	5 ohms	R10	14.5 - 15.5			115	Coarse voltage adjust
(-15 V, 5 A)			R16	15 ±0.1 V		3.0 A	115	Fine voltage adjust
	Ripple				1 mV			Maximum ripple
	Regulation	5 ohms and 55 ohms		15 ±0.1 V	1 mV	3.0 A and 0.27 A	105-125	Procedure 1
	Current limiting	4 ohms 3 ohms 2 ohms			1 mV 1 mV 1 mV	3.75 A 5.0 A 7.5 A	115	Procedure 2A
	Overvoltage	5 ohms	R10, R20	16.5		3.3 A	115	Procedure 4. R10 is output voltage adjust, R20 is overvoltage adjust.
	Preoperational verification	5 ohms	R10, R16	15 ±0.1 V	1 mV	3.0 A	115	Procedure 3
A1A4	Voltage	3 ohms	R13	5.5 ±0.1 V		1.8 A	115	Voltage adjust
(5.5 V, 5 A)	Ripple				1 mV			Maximum ripple
	Regulation	3 ohms and 33 ohms		5.5 ±0.1 V	1 mV	1.8 A and 0.17 A	105-125	Procedure 1
	Current limiting	2 ohms 1 ohm			1 mV 1 mV	2.75 A 5.5 A	115	Procedure 2A

Table 5–10. Minimum Performance Standards (Cont)

POWER SUPPLY	MINIMUM PERFORMANCE TEST FOR	RESISTIVE LOAD SETTING	OUTPUT VOLTAGE		RIPPLE MONITOR (RMS)	REGULATION		COMMENTS
			ADJUST VARIABLE RESISTOR	VTVM READING (V dc)		CURRENT OUTPUT ±10%	VARIAC OUTPUT (V ac)	
A1A4 (Cont)	Overvoltage	3 ohms	R13, R17	6.0		2.0 A	115	Procedure 4. R13 is output voltage adjust, R17 is overvoltage adjust.
	Preoperational verification	3 ohms	R13	5.5 ±0.1 V	1 mV	1.8 A	115	Procedure 3

Note: Clear areas indicate minimum performance standards. Shaded areas contain information pertinent to minimum performance testing parameters.

Table 5-10. Minimum Performance Standards (Cont)

Regulation Performance Test.	
Objective:	To verify output voltage and ripple stability during line and load fluctuations.
Procedure 1:	For each indicated resistive load setting, vary ac input voltage from 105 V to 125 V. Output voltage must remain within tolerances and ripple must not exceed 1 mV rms.
Current Limiting Performance Tests. (Two Procedures.)	
Objective:	To assure operation of overload self-protection circuitry.
Procedure 2A:	Decrease resistive load setting in 1 ohm increments until a current-limiting condition occurs. (A current-limiting condition is defined as the transfer in operation from constant voltage operation to constant current operation, with ultimate current-limiting operation being a short-circuited load, maximum current, and zero voltage. This transfer occurs when the output voltage begins to diminish, and the output current becomes constant.) Verify that ripple remains in tolerance. Verify that output current does not exceed rated capacity by more than 10 percent. Return resistive load to original setting. Power supply must immediately return to normal operation.
Procedure 2B:	This power supply requires a 15-ampere, 250-watt load with decade increments of 0.1 ohm. If a suitable load is not available, the current-limiting function can be tested by applying a short circuit to the output taps. The method recommended is to attach a 4-foot length of 22 AWG wire to the +OUT tap, and a 4-foot length of 22 AWG wire to the -OUT tap. If available, install a switch, capable of the voltage and current required, between the two lengths of wire. The 8-foot length of 22 AWG wire results in approximately 0.1 ohm resistance. Monitor the emitter of any series regulator transistor through the test. Apply the short circuit. The series regulator emitter should read between 0.25 V and 1.0 V, and the output current should be 15 A ±10 percent. Verify that the removal of the short circuit returns the power supply to normal operation. Ripple must remain within tolerance requirements.
Preoperational Verification Test.	
Objective:	Verification of power supply operational readiness.
Procedure 3:	Adjust resistive load and Variac output to required settings. Adjust output voltage resistor(s) to obtain required output voltage. Verify that ripple is less than 1 mV rms, and output current is within 10 percent of required value.

Table 5–10. Minimum Performance Standards (Cont)

Overvoltage Circuit Performance Test.	
Objective:	Adjustment and verification of silicon controlled rectifier overvoltage protection circuitry.
Procedure 4:	Adjust test equipment to required settings. Adjust output voltage resistor(s) to obtain the required threshold voltage. (If the SCR should fire during this adjustment, turn power supply OFF, increase resistance across the overvoltage protection potentiometer, turn power supply ON, and repeat adjustment of output voltage resistor(s).) Adjust the overvoltage protection potentiometer until the SCR fires. Turn power OFF, lower output voltage slightly, turn power ON, and raising the output voltage slowly, note the output voltage when the SCR fires. Repeat sequence two times to verify the overvoltage firing level. SCR circuit firing levels are 16.5 V to 17.0 V for the A3 (-15 V dc) power supply and 6.0 V ±0.2 V for the A4 (+5.5 V dc) power supply. Perform procedure 3 to return power supply to proper output voltage.

SECTION VI
REPLACEABLE PARTS LIST

6–1. GENERAL.

6-2. This section of the manual is designed to aid maintenance personnel in the identification and replacement of component parts of the system.

6-3. The replaceable parts lists contain figure numbers, index numbers, a description of each part, reference designations, the quantity of parts per unit, manufacturer's part number, and the manufacturer's code. Table 6-2 lists the various parts manufacturers by code.

6-4. Parts locations may be determined by reference to schematic diagrams, exploded view illustrations, and test illustrations.

6-5. Table 6-1 contains a complete listing of all of the parts list tables included in this section.

Table 6–1. Parts List Reference Index

TABLE NO.	TITLE	PAGE NO.
6-2	List of Manufacturers	6-2
6-3	List of Major Assemblies	6-3
6-4	Parts List, Power Supply A1A1	6-3
6-5	Parts List, Power Supply PCB A1A1A1	6-3
6-6	Parts List, Power Supply PCB A1A1A2	6-5
6-7	Parts List, Power Supply A1A2	6-10
6-8	Parts List, Power Supply PCB A1A2A1	6-13
6-9	Parts List, Power Supply A1A3	6-15
6-10	Parts List, Power Supply PCB A1A3A1	6-17
6-11	Parts List, Power Supply PCB A1A3A2	6-21
6-12	Parts List, Power Supply PCB A1A3A3	6-23
6-13	Parts List, Power Supply PCB A1A3A4	6-25
6-14	Parts List, Power Supply A1A4	6-25
6-15	Parts List, Power Supply PCB A1A4A1	6-25

Table 6-2. List of Manufacturers

CODE NO.	MANUFACTURER
01686	RCL Electronics, Inc. 195 McGregor St. Manchester, NH 03102
02735	RCA Corporation Solid State Division Route 202 Somerville, NJ 08876
04713	Motorola, Inc. Semiconductor Products Division 5005 East McDowell Rd. Phoenix, AZ 85008
07263	Fairchild Semiconductor A Division of Fairchild Camera and Instrument Corp. 464 Ellis St. Mountain View, CA 94042
09019	General Electric Co. Semiconductor Products Dept., Operational Planning Section Carroll Ave. Lynchburg, VA 24502
14604	Elmwood Sensors, Inc. 1655 Elmwood Avenue Cranston, RI 02907
14655	Cornell-Dubilier Electronics Division of Federal Pacific Electric Co., Government Contracts Dept. 150 Avenue L Newark, NJ 07101
23934	Power/Mate Corp. 514 S. River St. Hackensack, NJ 07601
56289	Sprague Electric Co. North Adams, MA 01247
71400	Bussman Mfg. Division of McGraw-Edison Co. 2536 W. University St. St. Louis, MO 63107
71450	CTS Corp. 1142 W. Beardsley Ave. Elkhart, IN 46514
72825	Hugh H. Eby, Inc. 4701 Germantown Ave. Philadelphia, PA 19144
75042	TRW Electronic Components, IRC Fixed Resistors, Philadelphia Division 401 North Broad St. Philadelphia, PA 19108
75382	Kulka Electric Corp. 633-643 South Fulton Ave. Mount Vernon, NY 10550
75915	Littlefuse, Inc. 800 E. Northwest Hwy. DesPlains, IL 60016
81349	Military Specifications Promulgated by Military Departments/ Agencies Under Authority of Defense Standardization Manual 4120 3-M
81350	Joint Army-Navy Specifications Promulgated by Military Departments Under Authority of Defense Standardization Manual 4120 3-M
83701	Electronic Devices, Inc. 21 Gray Oaks Ave. Yonkers, NY 10710
90201	Mallory Capacitor Co. Division of P.R. Mallory and Co., Inc. 3029 East Washington St. PO Box 372 Indianapolis, IN 46206
94589	Dickson Co. 7420 S. Woodlawn Ave. Chicago, IL 60619

Table 6-3. List of Major Assemblies

REFERENCE DESIGNATION	FIGURE & INDEX NO.	MAJOR ASSEMBLY	MFR. CODE NO.	PART NUMBER	QTY.
A1A1	5-1	Power supply, +28 V dc (Refer to Table 6-4 for breakdown.)	23934	OEM 28A-P1823	1
A1A2	5-1	Power supply, +15 V dc (Refer to Table 6-7 for breakdown.)	23934	OEM 15F-C P1820	1
A1A3	5-1	Power supply, -15 V dc (Refer to Table 6-9 for breakdown.)	23934	PXS C 15V 5A	1
A1A4	5-1	Power supply, +5.5 V dc (Refer to Table 6-14 for breakdown.)	23934	PLI 5.5V P1822	1

Table 6-4. Parts List, Power Supply A1A1

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A1	6-1	Power supply, +28 V dc	23934	OEM 28A-P1823	1
A1	6-1-1	Power supply PCB (Refer to Table 6-5 for breakdown.)	23934		1
A2	6-1-3	Power supply PCB (Refer to Table 6-6 for breakdown.)	23934		1
Q1	6-1-5	Transistor, NPN silicon	81350	2N3055	1
T1	6-1-2	Transformer, power	23934	21276	1
XQ1	6-1-4	Socket, transistor	72825	9866-15-1	1

Table 6-5. Parts List, Power Supply PCB A1A1A1

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A1A1	6-2	Power supply printed circuit board	23934		1
C1 thru C6	Used on A1A1A2				
C7		Capacitor, electrolytic, 68 μF, 60 V dcw	56289	137D686X0060T2	1

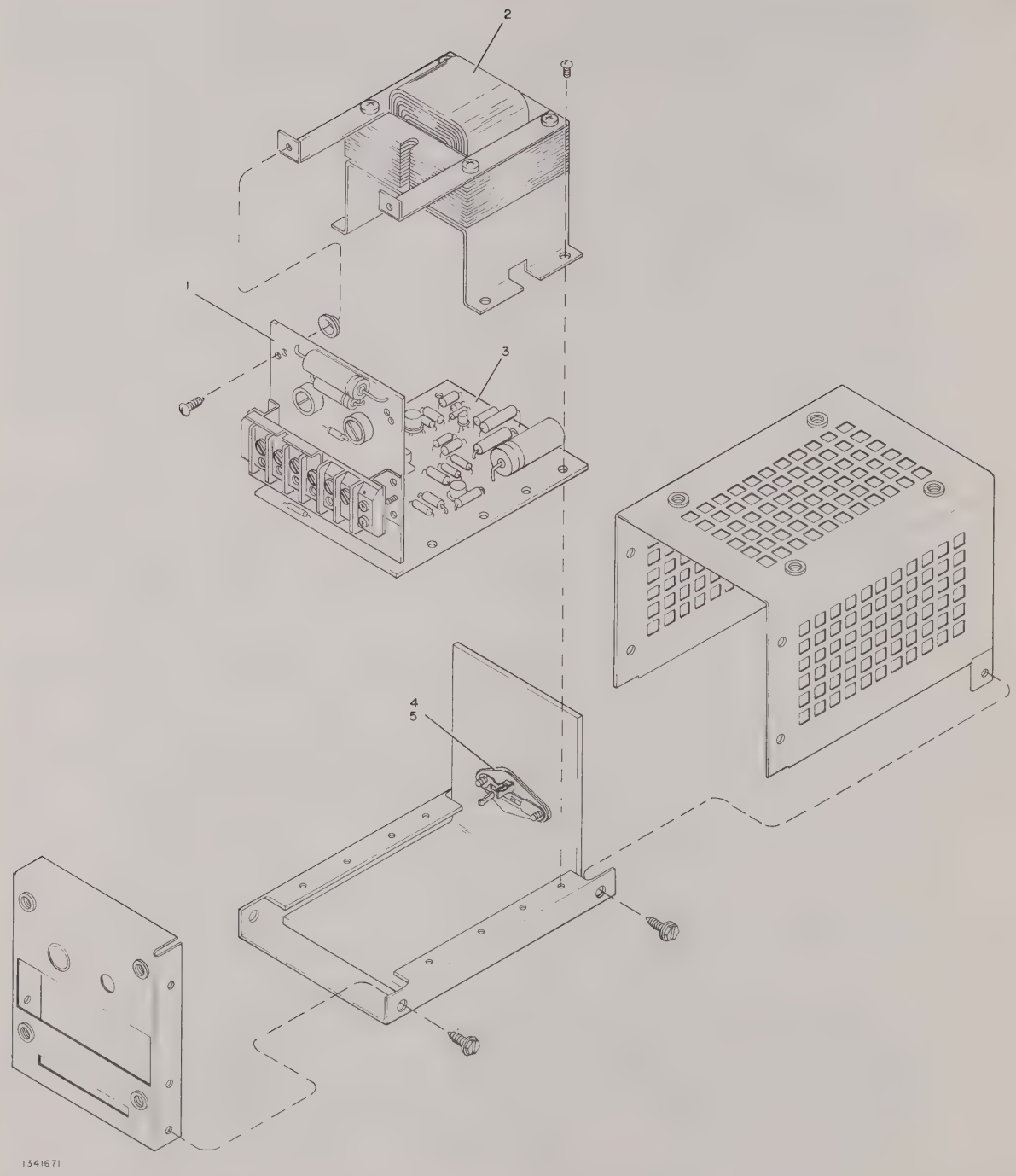


Figure 6–1. Power Supply A1A1, Exploded View

Table 6-5. Parts List, Power Supply PCB A1A1A1 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
C8		Capacitor, electrolytic, 18 μF, 60 Vdcw	56289	137D186X0060C2	1
CR1 thru CR14	Used on A1A1A2				
CR15, CR16		Diode, rectifier, 1A, 100 PIV	81350	1N4002	2
R1 thru R14	Used on A1A1A2				
R15		Resistor, fixed, comp., 1k ±5%, 2 W	81349	RC42G102J	1
R16	Used on A1A1A2				
R17		Resistor, variable, wirewound, 4k ±5%, 1 W	75042	Type 100 - 4k	1
R18		Resistor, variable, wirewound, 100 ohm ±5%, 1 W	75042	Type 500 - 100	1
TB1		Terminal strip, 6-position	75382	600 - C - 6	1

Table 6-6. Parts List, Power Supply PCB A1A1A2

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A1A2	6-3	Power supply printed circuit board	23934		1
C1		Capacitor, electrolytic, 2600 μF, 50 Vdcw	56289	36D242G050AA2A	1
C2		Capacitor, electrolytic, 150 μF, 60 Vdcw	56289	167D157X0060W2	1
C3	Not used				
C4		Capacitor, electrolytic, 2.7 μF, 50 Vdcw	81349	CSR13G275KL	1
C5		Capacitor, electrolytic, 0.68 μF, 50 Vdcw	81349	CSR13G684KL	1
C6		Capacitor, ceramic disc, 0.01 μF, 100 V	81349	CO23B101F103M	1
CR1 thru CR4		Diode, rectifier, 1 A, 100 PIV	81350	1N4002	4

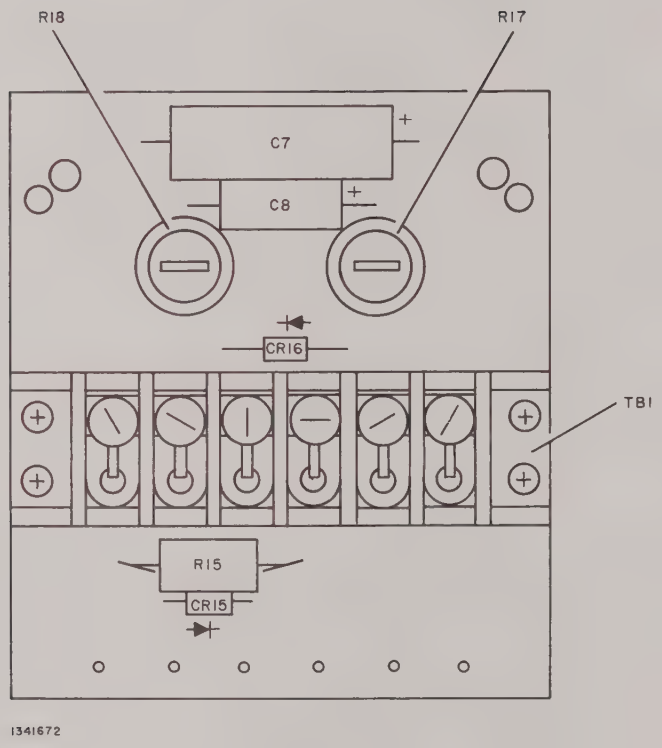


Figure 6–2. Power Supply Printed Circuit Board A1A1A1, Parts Location

Table 6-6. Parts List, Power Supply PCB A1A1A2 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
CR5	Not used				
CR6		Diode, rectifier, 1 A, 100 PIV	81350	1N4002	1
CR7 thru CR9	Not used				
CR10		Diode, zener, 15 V, 1 W	81350	1N4744	1
CR11		Diode, zener, 6.2 V, 0.5 W	81350	1N5234	1
CR12		Diode, zener, 6.2 V, 0.25 W	81350	1N823	1
CR13, CR14		Diode, rectifier, 1 A, 100 PIV	81350	1N4002	2
Q1	Used on A1A1				
Q2		Transistor, NPN, silicon	81350	2N2105	1
Q3, Q4		Transistor, NPN, silicon	81350	2N3858A	2
Q5/Q6		Transistor, PNP, differential pair	07263	SE 4902	1
Q7		Transistor, PNP, silicon	81350	2N4037	1
Q8		Transistor, silicon, field effect N-channel	81350	2N5457	1
R1		Resistor, fixed, comp., 68 ohm ±5%, 1/2 W	81349	RC20G680J	1
R2		Resistor, fixed, comp., 330 ohm ±5%, 2 W	81349	RC42G331J	1
R3		Resistor, fixed, film, insulated, 150 ohm ±5%, 1/2 W	81349	RL20S151J	1
R4		Resistor, fixed, comp., 560 ohm ±5%, 1/2 W	81349	RC20G561J	1
R5	6-3	Resistor, fixed, film, insulated, 680 ohm ±5%, 1/2 W	81349	RL20S681J	1

Table 6–6. Parts List, Power Supply PCB A1A1A2 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
R6		Resistor, fixed, film, insulated, 390 ohm ±5%, 1/2 W	81349	RL20S391J	1
R7		Resistor, fixed, comp., 22 ohm ±5%, 1/2 W	81349	RC20G220J	1
R8		Resistor, fixed, comp., 1 ohm ±5%, 2 W	81349	RC42G1R0J	1
R9		Resistor, fixed, comp., 3.3k ±5%, 1/2 W	81349	RC20G332J	1
R10		Resistor, fixed, comp., 47k ±5%, 1/2 W	81349	RC20G473J	1
R11	Not used				
R12		Resistor, fixed, film, insulated, 680 ohm ±5%, 1/2 W	81349	RL20S681J	1
R13		Resistor, fixed, film, insulated, 390 ohm ±5%, 1/2 W	81349	RL20S391J	1
R14		Resistor, fixed, comp., 3.3k ±5%, 1/2 W	81349	RC20G332J	1
R15	Used on A1A1A1				
R16		Resistor, fixed, film, insulated, 390 ohm ±5%, 1/2 W	81349	RL20S391J	1
R17, R18	Used on A1A1A1				
R19		Resistor, fixed, film, insulated, 150 ohm ±5%, 1/2 W	81349	RL20S151J	1
R20		Resistor, fixed, comp., 390 ohm ±5%, 1/2 W	81349	RC20G391J	1

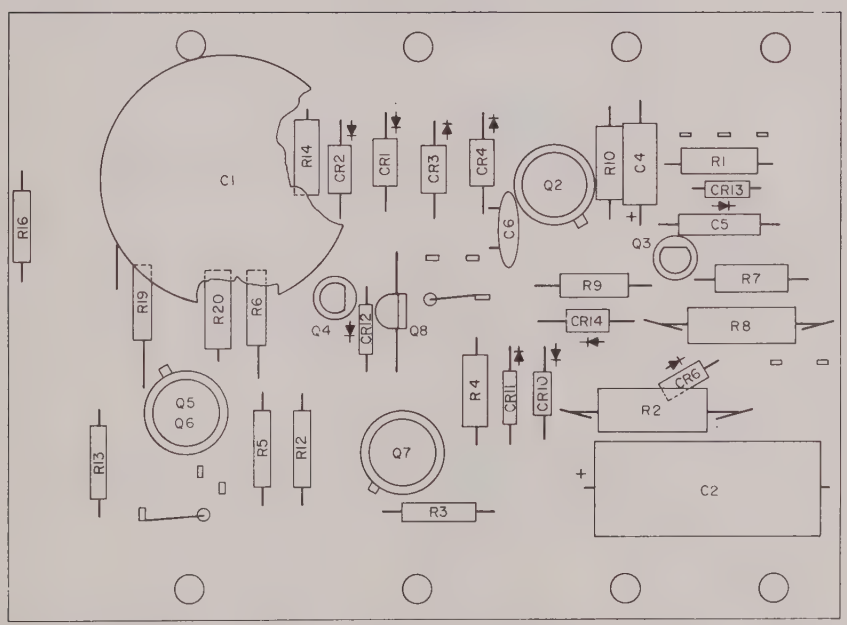


Figure 6–3. Power Supply Printed Circuit Board A1A1A2, Parts Location

Table 6-7. Parts List, Power Supply A1A2

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A2	6-4	Power supply, +15 V dc	23934	OEM 15F-C-P1820	1
A1	6-4-3	Power supply PCB (Refer to Table 6-8 for breakdown.)	23934		1
C1	Used on A1A2A1				
C2	6-4-9	Capacitor, ceramic disc, 0.05 μF, 500 V	81349	CO23A501P503M	1
C3	6-4-5	Capacitor, electrolytic, 24,000 μF, 40 Vdcw	90201	CG243U35G1	1
CR1 thru CR4	6-4-10	Diode, rectifier, 35 A, 150 PIV	81350	1N1185A	4
Q1	6-4-11	Transistor, NPN, silicon	81350	2N3055	1
Q2 thru Q8	Used on A1A2A1				
Q9 thru Q14		Transistor, NPN, silicon	81350	2N3055	6
R1 thru R6	Used on A1A2A1				
R7	6-4-13	Resistor, fixed, wirewound, 0.064 ohm ±3%, 20 W	01686	AL-25	6
R8 thru R21	Used on A1A2A1				
R23	6-4-2	Resistor, fixed, wirewound, 4.7k ±5%, 3 W	81349	RW79V472J	1
R24	Used on A1A2A1				
R25 thru R28	6-4-7	Wire, resistance, 0.1 ohm (2 inches)	81349	RW2B	4
R29	6-4-4	Resistor, fixed, wirewound, 1k ±5%, 3 W	81349	RW79V102J	1
R30, R31	6-4-7	Wire, resistance, 0.1 ohm (2 inches)	81349	RW2B	2
T1	6-4-8	Transformer, power	23934	015-F	1
TB1	6-4-1	Terminal strip, 6-position	75382	602-C-6	1
TS1	6-4-12	Switch, thermal	14604	L552-46	1

Table 6-7. Parts List, Power Supply A1A2 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
XQ1	6-4-6	Socket, transistor	72825	9866-15-1	1
XQ2 thru XQ8	Not used				
XQ9 thru XQ14	6-4-6	Socket, transistor	72825	9866-15-1	6

Table 6-8. Parts List, Power Supply PCB A1A2A1

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A2A1	6-5	Power supply printed circuit board	23934		1
C1		Capacitor, electrolytic, 440 μF, 50 Vdcw	56289	601D447G030HE4	1
C2, C3	Used on A1A2				
C4		Capacitor, ceramic disc, 0.01 μF, 100 V	81349	CO23B101F103M	1
C5		Capacitor, electrolytic, 0.68 μF, 50 Vdcw	81349	CSR13G684KL	1
C6		Capacitor, electrolytic, 2.7 μF, 50 Vdcw	81349	CSR13G275KL	1
C7		Capacitor, electrolytic, 680 μF, 50 Vdcw	56289	601D687G050JJ4	1
C8		Capacitor, electrolytic, 22 μF, 50 Vdcw	81349	CSR13G226KL	1
C9		Capacitor, ceramic disc, 0.002 μF, 1000 V	81349	CO23B102F202P	1
CR1 thru CR4	Used on A1A2				
CR5		Diode, zener, 15 V, 1 W	81350	1N4744	1
CR6		Diode, zener, 6.2 V, 0.5 W	81350	1N5234A	1
CR7		Diode, zener, 6.2 V, 0.25 W	81350	1N823A	1
CR8		Diode, rectifier, 3 A, 200 PIV	81350	1N4141	1
CR9 thru CR12		Diode, rectifier, 1 A, 100 PIV	81350	1N4002	1

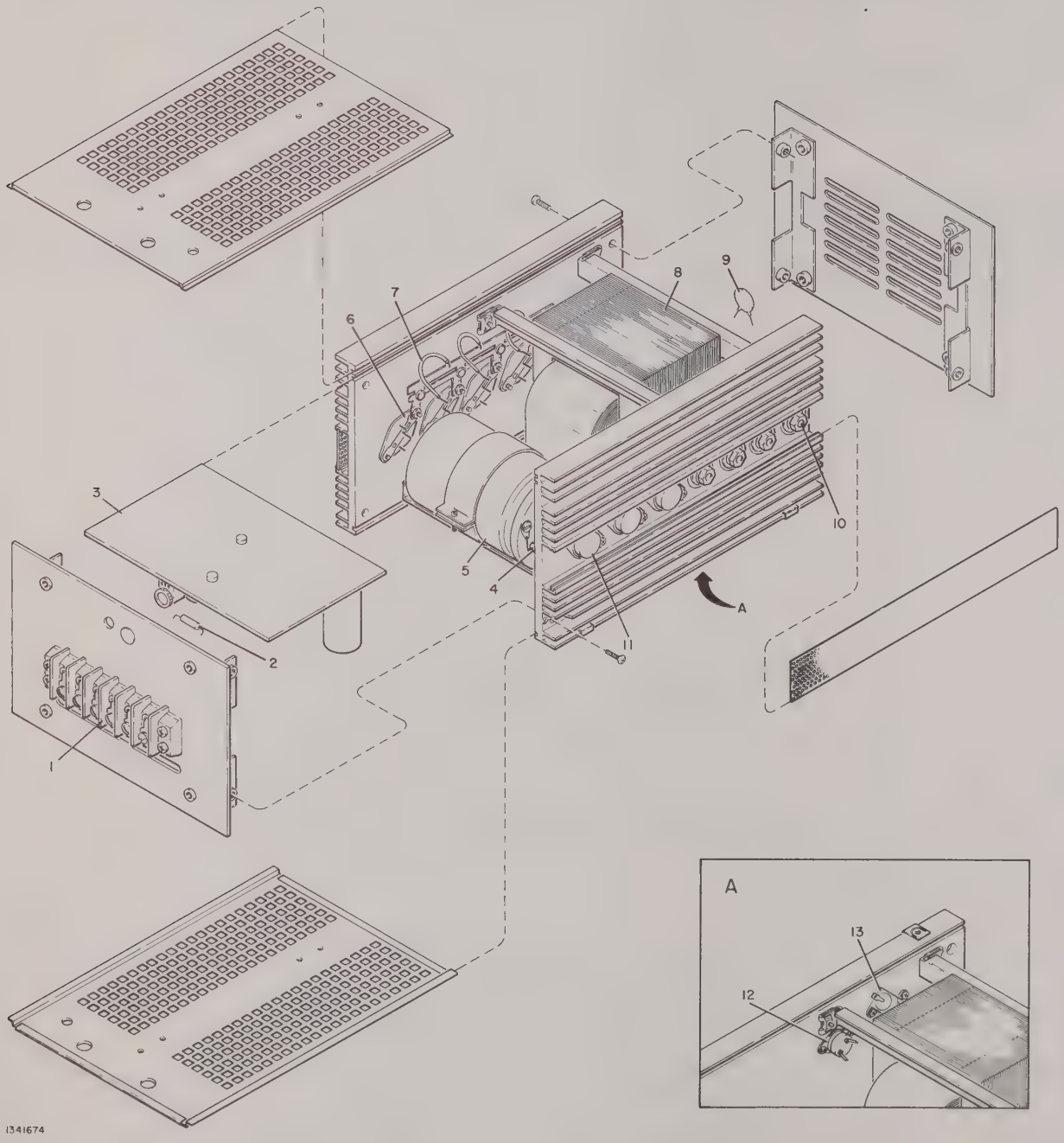


Figure 6–4. Power Supply A1A2, Exploded View

Table 6-8. Parts List, Power Supply PCB A1A2A1 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
Q1	Used on A1A2				
Q2		Transistor, NPN, silicon	81350	2N2102	1
Q3		Transistor, NPN, silicon	81350	2N3569	1
Q4		Transistor, NPN, silicon	81350	2N3568	1
Q5/Q6		Transistor, PNP, silicon, differential pair	07263	SE4902	1
Q7		Transistor, NPN, silicon	81350	2N3569	1
Q8		Transistor, PNP, silicon	81350	2N3638	1
R1		Resistor, fixed, comp., 120 ohm ±5%, 2 W	81349	RC42G121J	1
R2		Resistor, fixed, film, insulated, 180 ohm ±5%, 1/2 W	81349	RL20S181J	1
R3	6-5	Resistor, fixed, film, insulated, 680 ohm ±5%, 1/2 W	81349	RL20S681J	1
R4, R5		Resistor, fixed, film, insulated, 390 ohm ±5%, 1/2 W	81349	RL20S391J	5
R6		Resistor, fixed, film, insulated, 2.2k ±5%, 1/2 W	81349	RL20S222J	1
R7	Used on A1A2				
R8		Resistor, fixed, film, insulated, 680 ohm ±5%, 1/2 W	81349	RL20S681J	1
R9		Resistor, fixed, film, insulated, 390 ohm ±5%, 1/2 W	81349	RL20S391J	1
R10		Resistor, fixed, comp., 22 ohm ±5%, 1/2 W	81349	RC20G220J	1

Table 6–8. Parts List, Power Supply PCB A1A2A1 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
R11		Resistor, fixed, comp., 3.3k ±5%, 1/2 W	81349	RC20G332J	1
R12		Resistor, fixed, comp., 47k ±5%, 1/2 W	81349	RC20G473J	1
R13		Resistor, fixed, film, insulated, 220 ohm ±5%, 1/2 W	81349	RL20S221J	1
R14		Resistor, fixed, film, insulated, 390 ohm ±5%, 1/2 W	81349	RL20S391J	1
R15		Resistor, fixed, film, insulated, 150 ohm ±5%, 1/2 W	81349	RL20S151J	1
R16		Resistor, variable, wirewound, 100 ohm ±5%, 1 W	75042	Type 506-100	1
R17		Resistor, variable, wirewound, 3.2k ±5%, 1 W	75042	Type 106 - 3.2k	1
R18		Resistor, fixed, comp., 560 ohm ±5%, 1/2 W	81349	RC20G561J	1
R19		Resistor, fixed, comp., 68 ohm ±5%, 1/2 W	81349	RC20G680J	1
R20	Not used				
R21		Resistor, fixed, comp., 680 ohm ±5%, 1/2 W	81349	RC20G681J	1
R22	Not used				
R23	Used on A1A2				
R24		Resistor, fixed, film, insulated, 390 ohm ±5%, 1/2 W	81349	RL20S391J	1
R25 thru R31	Used on A1A2				
R32 thru R37	Not used				

Table 6-8. Parts List, Power Supply PCB A1A2A1 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
R38	6-5	Resistor, fixed, comp., 220 ohm ±5%, 2 W	81349	RC42G221J	1
R39 thru R44	Not used				
R45		Resistor, fixed, film, insulated, 6.8k ±5%, 1/2 W	81349	RL20S682J	1

Table 6-9. Parts List, Power Supply A1A3

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A3	6-6	Power supply, -15 V dc	23934	PXS C 15V 5A	1
A1	6-6-8	Power supply PCB (Refer to Table 6-10 for breakdown.)	23934		1
A2	6-6-9	Power supply PCB (Refer to Table 6-11 for breakdown.)	23934		1
A3	6-6-2	Power supply PCB (Refer to Table 6-12 for breakdown.)	23934		1
A4	6-6-3	Power supply PCB (Refer to Table 6-13 for breakdown.)	23934		1
C1	6-6-10	Capacitor, dipped mica, 0.47 μF, 500 V	81349	CM08FD473J031	1
C2	6-6-12	Capacitor, ceramic disc, 0.1 μF, 100 V	81349	CO23B101F103M	1
C3	6-6-14	Capacitor, electrolytic, 30,000 μF, 25 Vdcw	56289	36D303G025BC2A	1
CR1 thru CR4	6-6-13	Rectifier bridge, encapsulated, 25 A, 200 PIV	83701	PB20	1
F1	6-6-7	Fuse, 3 A, slow blow	75915	3AG/MDL	1
F2	6-6-5	Fuse, 6 A, slow blow	75915	6AG/MDL	1
Q1 thru Q4	6-6-1	Transistor, NPN, silicon	81350	2N3055	4

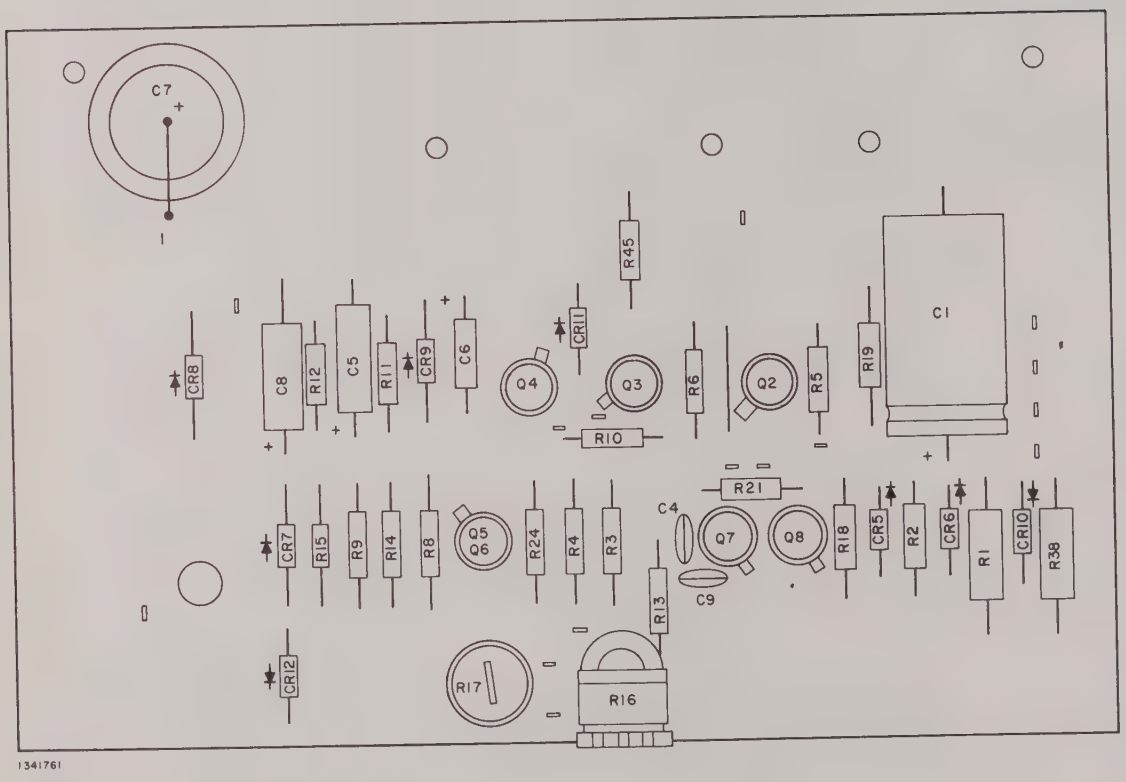


Figure 6–5. Power Supply Printed Circuit Board A1A2A1, Parts Location

Table 6–9. Parts List, Power Supply A1A3 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
R1	6-6-15	Resistor, fixed, wire-wound, 400 ohm ±5%, 3 W	01686	TR-2A	1
T1	6-6-6	Transformer, power	23934	PXSC-15	1
TB1	6-6-11	Terminal strip, 7-position	75382	699-C-Z-7	1
XF1, XF2	6-6-4	Fuse block (for 1/4 x 1-1/4 fuses)	71400	3823-1	2

Table 6–10. Parts List, Power Supply PCB A1A3A1

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A3A1	6-7	Power supply printed circuit board	23934		1
C1 thru C3	Used on A1A3				
C4, C5		Capacitor, tantalum, 4.7 μF, 35 V	94589	D4R7GSA35M	2
C6		Capacitor, dipped mica, 0.047 μF, 500 V	81349	CM06FD472J03	1
C7, C8		Capacitor, tantalum, 4.7 μF, 35 V	94589	D4R7GSA35M	2
CR1 thru CR4	Used on A1A3				
CR5		Diode, rectifier, 1 A, 100 PIV	81350	1N4002	1
CR6		Diode, zener, 5.1 V, 0.4 W	81350	1N751A	1
CR7		Diode, rectifier, 1 A, 100 PIV	81350	1N4002	1
Q1 thru Q4	Used on A1A3				
Q5		Transistor, PNP, silicon	81350	2N4037	1
R1	Used on A1A3				
R2, R3	Used on A1A3A3				

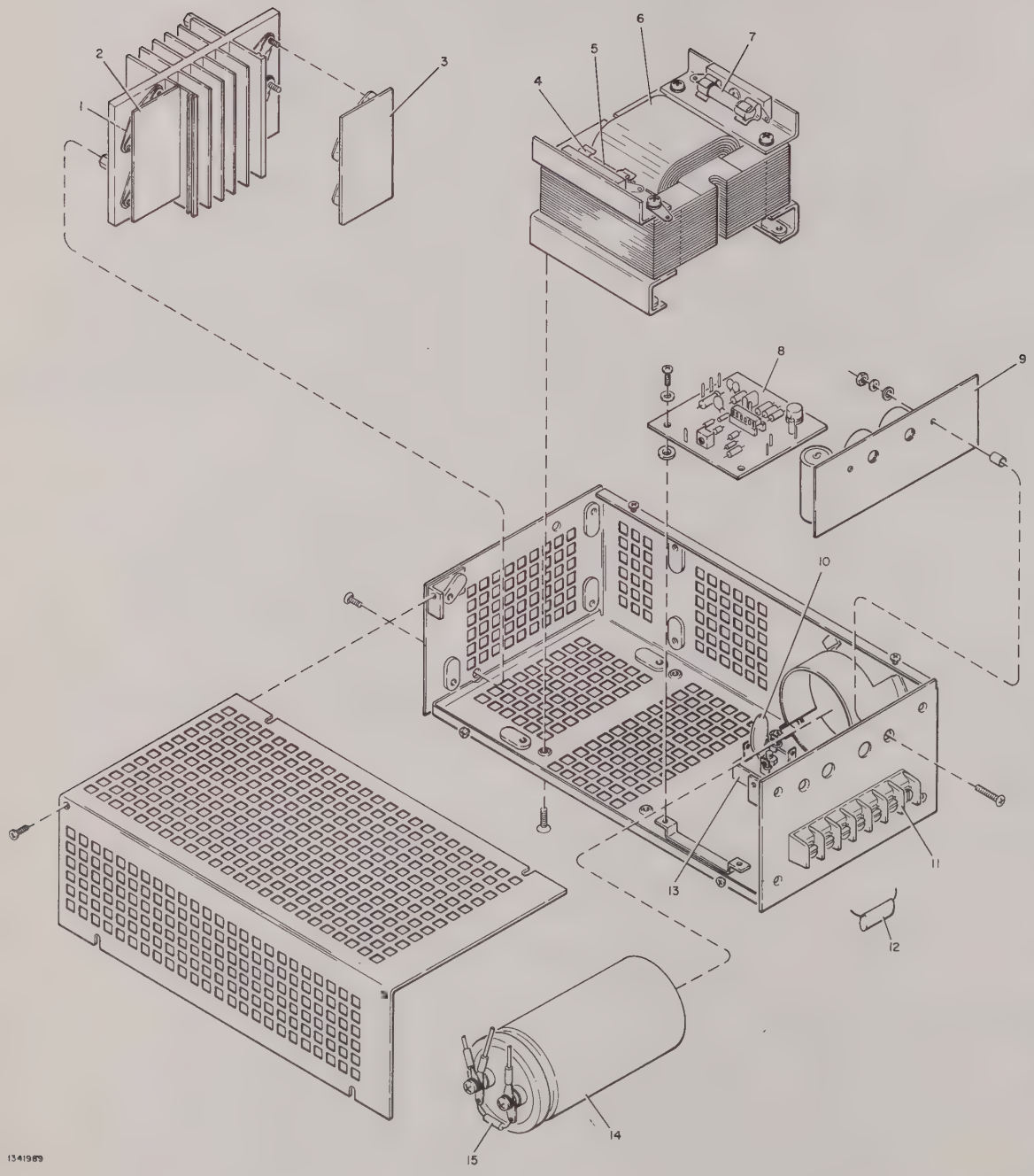


Figure 6–6. Power Supply A1A3, Exploded View

Table 6-10. Parts List, Power Supply PCB A1A3A1 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
R4, R5	Used on A1A3A4				
R6		Resistor, fixed, comp., 100 ohm ±5%, 1/2 W	81349	RC20G101J	1
R7		Resistor, fixed, comp., 1.2k ±5%, 1/2 W	81349	RC20G122J	1
R8		Resistor, fixed, comp., 680 ohm ±5%, 1/2 W	81349	RC20G681J	1
R9		Resistor, fixed, film, insulated, 100 ohm ±5%, 1/2 W	81349	RL20S101J	1
R10		Resistor, variable, cermet, 5k ±20%, 1 W	71450	360S502B	1
R11		Resistor, fixed, film, insulated, 820 ohm ±5%, 1/2 W	81349	RL20S821J	1
R12		Resistor, fixed, film, insulated, 180 ohm ±5%, 1/2 W	81349	RL20S181J	1
R13		Resistor, fixed, comp., 56 ohm ±5%, 1/2 W	81349	RC20G560J	1
R14		Resistor, fixed, comp., 1.2k ±5%, 1/2 W	81349	RC20G122J	1
R15 thru R26	Used on A1A3A2				
R27		Resistor, fixed, comp., 575 ohm ±1%, 1 W	75042	CEC	1
U1		Integrated circuit, voltage regulator μA723	07263	U6A7723393	1

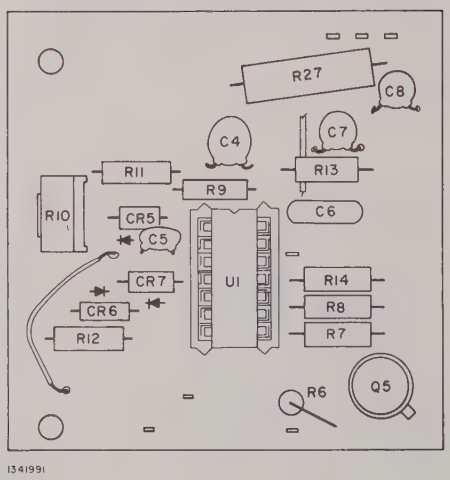


Figure 6–7. Power Supply Printed Circuit Board A1A3A1, Parts Location

Table 6–11. Parts List, Power Supply PCB A1A3A2

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A3A2	6–8	Power supply printed circuit board	23934		1
C1 thru C3	Used on A1A3				
C4 thru C8	Used on A1A3A1				
C9		Capacitor, electrolytic, 0.68 μF, 35 V	81349	CSR13G684KL	1
C10		Capacitor, electrolytic, 440 μF, 30 Vdcw	56289	601D447G030HE4	1
CR1 thru CR4	Used on A1A3				
CR5 thru CR7	Used on A1A3A1				
CR8 thru CR10		Diode, rectifier, 1 A, 100 PIV	81350	1N4002	3
Q1 thru Q4	Used on A1A3				
Q5	Used on A1A3A1				
Q6		Transistor, PNP, silicon	81350	2N4354	1
Q7		Transistor, NPN, silicon	81350	2N3568	1
R1	Used on A1A3				
R2, R3	Used on A1A3A3				
R4, R5	Used on A1A3A4				
R6 thru R14	Used on A1A3A1				
R15		Resistor, fixed, film, insulated, 930 ohm ±5%, 1/2 W	81349	RL20S931J	1
R16		Resistor, variable, wirewound, 500 ohm ±20%, 2 W	71450	115-R501A	1
R17, R18		Resistor, fixed, comp., 1.2k ±5%, 1/2 W	81349	RC20G122J	2

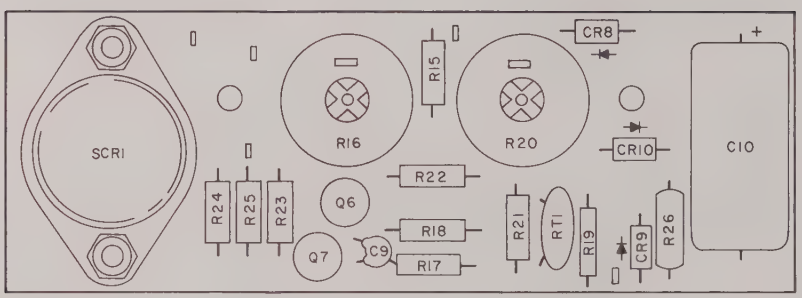


Figure 6–8. Power Supply Printed Circuit Board A1A3A2, Parts Location

Table 6-11. Parts List, Power Supply PCB A1A3A2 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
R19		Resistor, fixed, film, insulated, 180 ohm ±5%, 1/2 W	81349	RL20S181J	1
R20		Resistor, variable, wirewound, 2k ±20%, 2 W	71450	115-R202A	1
R21, R22		Resistor, fixed, comp., 82 ohm ±5%, 1/2 W	81349	RC20G820J	2
R23		Resistor, fixed, comp., 15k ±5%, 1/2 W	81349	RC20G153J	1
R24		Resistor, fixed, comp., 22 ohm ±5%, 1/2 W	81349	RC20G220J	1
R25		Resistor, fixed, comp., 1.2k ±5%, 1/2 W	81349	RC20G122J	1
R26		Resistor, fixed, wirewound, 400 ohm ±5%, 3 W	01686	TR-2A	1
RT1		Thermistor, 25 ohm ±10%, 1/2 W	09019	2D404	1
SCR1		Silicon controlled rectifier	81350	2N3669	1

Table 6-12. Parts List, Power Supply PCB A1A3A3

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A3A3	6-9	Power supply printed circuit board	23934		1
R1	Used on A1A3				
R2		Resistor, fixed, comp., 47 ohm ±5%, 1/2 W	81349	RC20G470J	1
R3		Wire, resistance, 0.1 ohm (2 inches)	81349	RW2B	1
XQ1, XQ2		Socket, transistor	72825	9866-15-1	2

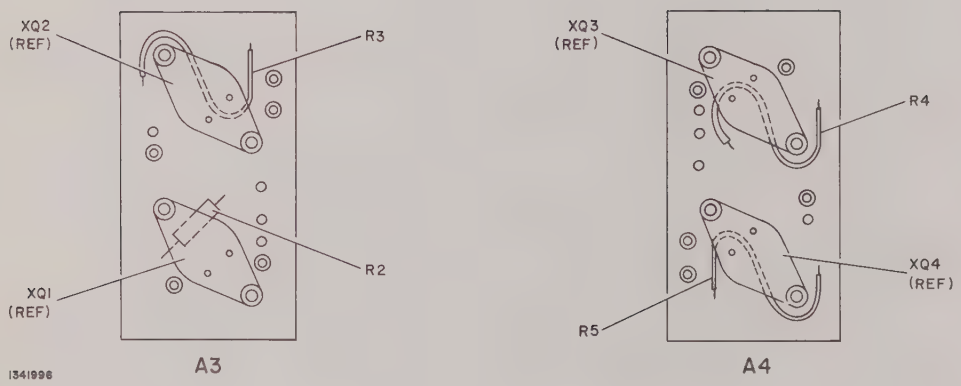


Figure 6–9. Power Supply Printed Circuit Boards A1A3A3 and A1A3A4, Parts Location

Table 6–13. Parts List, Power Supply PCB A1A3A4

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A3A4	6-9	Power supply printed circuit board	23934		1
R1	Used on A1A3				
R2, R3	Used on A1A3A3				
R4, R5		Wire, resistance, 0.1 ohm (2 inches)	81349	RW2B	2
XQ1, XQ2	Used on A1A3A3				
XQ3, XQ4		Socket, transistor	72825	9866-15-1	2

Table 6–14. Parts List, Power Supply A1A4

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A4	6-10	Power supply, +5.5 V dc	23934	PLI 5.5V P1822	1
A1	6-10-3	Power supply PCB (Refer to Table 6-15 for breakdown.)	23934		1
CR1, CR2	6-10-2	Diode, rectifier, 18 A 100 PIV	02735	40209	2
T1	6-10-1	Transformer, power	23934	ICY-5-C	1

Table 6–15. Parts List, Power Supply PCB A1A4A1

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
A1A4A1	6-11	Power supply printed circuit board	23934		1
C1		Capacitor, electrolytic, 39,000 μF, 15 V	09019	86F1419MA	1
C2		Capacitor, electrolytic, 120 μF, 30 Vdcw	56289	600D127G030DG4	1
C3		Capacitor, electrolytic, 20 μF, 64 Vdcw	56289	500D206G050CC7	1
C4		Capacitor, ceramic disc, 250 μμF, 1000 V	81349	CO23B102E251M	1

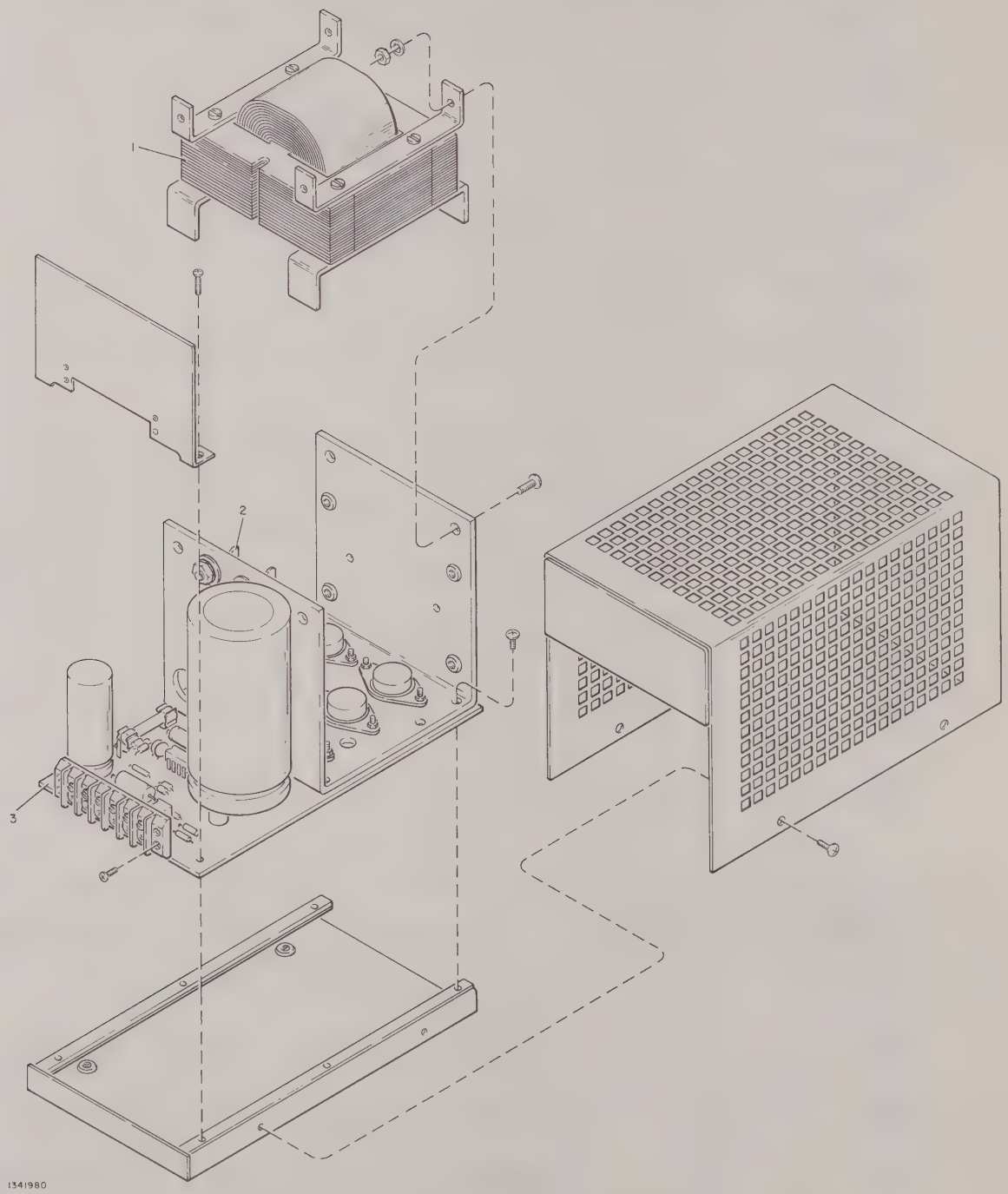


Figure 6–10. Power Supply A1A4, Exploded View

Table 6–15. Parts List, Power Supply PCB A1A4A1 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
C5		Capacitor, ceramic disc, 100 μμF, 1000 V	81349	CO23B102E101M	1
C6		Capacitor, electrolytic, 1900 μF, 25 Vdcw	56289	601D198G025GT4	1
C7		Capacitor, electrolytic, 27 μF, 50 Vdcw	81349	CSR13G275KL	1
C8		Capacitor, ceramic disc, 0.01 μF, 100 V	81349	CO23B101F103M	1
CR1, CR2	Used on A1A4A1				
CR3 thru CR7		Diode, rectifier, 1 A, 100 PIV	81350	1N4002	5
CR8		Diode, rectifier, 3 A, 200 PIV	81350	1N4141	1
CR9		Diode, rectifier, 1 A, 100 PIV	81350	1N4002	1
F1		Fuse, 12 A	79515	3AB	1
Q1 thru Q4		Transistor, NPN, silicon	81350	2N3055	4
Q5		Transistor, PNP, silicon	81350	2N3644	1
Q6		Transistor, NPN, silicon	81350	2N3568	1
R1		Resistor, fixed, wirewound, 100 ohm ±3%, 3 W	01686	TR-2A	1
R2		Resistor, fixed, comp., 100 ohm ±5%, 1/2 W	81349	RC20G101J	1
R3		Resistor, fixed, comp., 51 ohm ±5%, 1/2 W	81349	RC20G510J	1
R4 thru R6	6-11	Resistor, fixed, wirewound, 0.067 ohm ±1%, 2 W	01686	BR-2	3
R7		Resistor, fixed, wirewound, 0.08 ohm ±1%, 10 W	01686	AL-10	1
R8		Resistor, fixed, comp., 15k ±5%, 1/2 W	81349	RC20G153J	1

Table 6-15. Parts List, Power Supply PCB A1A4A1 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
R9		Resistor, fixed, film, insulated, 680 ohm ±5%, 1/2 W	81349	RL20S681J	1
R10		Resistor, fixed, film, insulated, 100 ohm ±5%, 1/2 W	81349	RL20S101J	1
R11		Resistor, fixed, film, insulated, 330 ohm ±5%, 1/2 W	81349	RL20S331J	1
R12		Resistor, fixed, film, insulated, 180 ohm ±5%, 1/2 W	81349	RL20S181J	1
R13		Resistor, variable, cermet, 2k ±20%, 1 W	71450	PF 8 202	1
R14, R15		Resistor, fixed, comp., 1.2k ±5%, 1/2 W	81349	RC20G122J	2
R16		Resistor, fixed, comp., 270 ohm ±5%, 1/2 W	81349	RC20G271J	1
R17		Resistor, variable, cermet, 5k ±20%, 1 W	71450	360T502B	1
R18		Resistor, fixed, comp., 56 ohm ±5%, 1/2 W	81349	RC20G560J	1
R19		Resistor, fixed, comp., 22 ohm ±5%, 1/2 W	81349	RC20G220J	1
R20		Resistor, fixed, comp., 47 ohm ±5%, 1/2 W	81349	RC20G470J	1
R21		Resistor, fixed, comp., 16k ±5%, 1/2 W	81349	RC20G163J	1
R22		Resistor, fixed, comp., 1.2k ±5%, 1/2 W	81349	RC20G122J	1
RT1		Thermistor, 25 ohm ±10%, 1/2 W	09019	2D404	1
SCR1		Silicon controlled rectifier	81350	2N3669	1

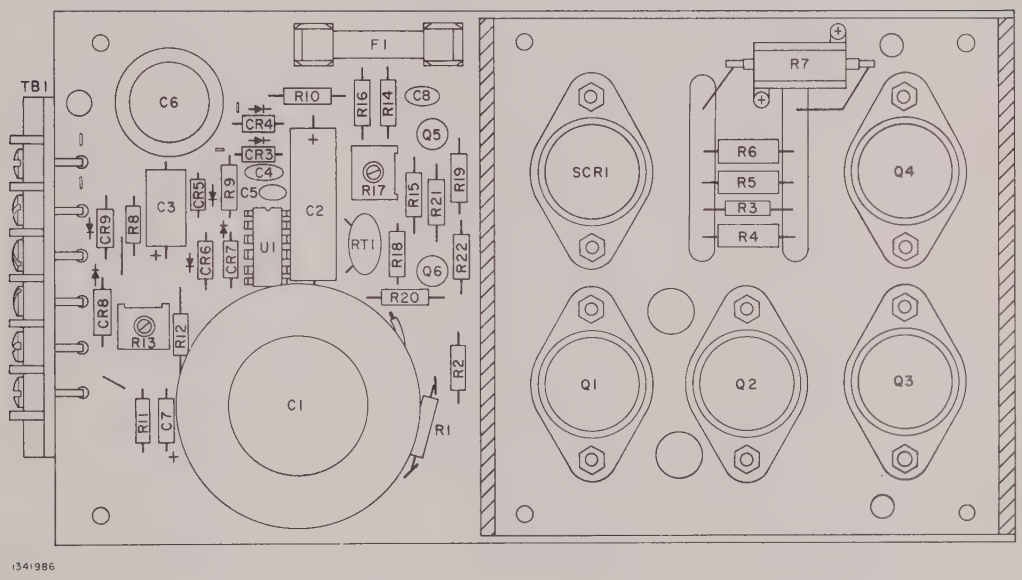


Figure 6–11. Power Supply Printed Circuit Board A1A4A1, Parts Location

Table 6–15. Parts List, Power Supply PCB A1A4A1 (Cont)

REFERENCE DESIGNATION	FIGURE & INDEX NO.	DESCRIPTION	MFR. CODE NO.	PART NUMBER	QTY.
TB1		Terminal strip, 6 position	75383	600 C 6	1
U1		Integrated circuit, voltage regulator, μA723	07263	U6A7723393	1

SECTION VII
DRAWINGS

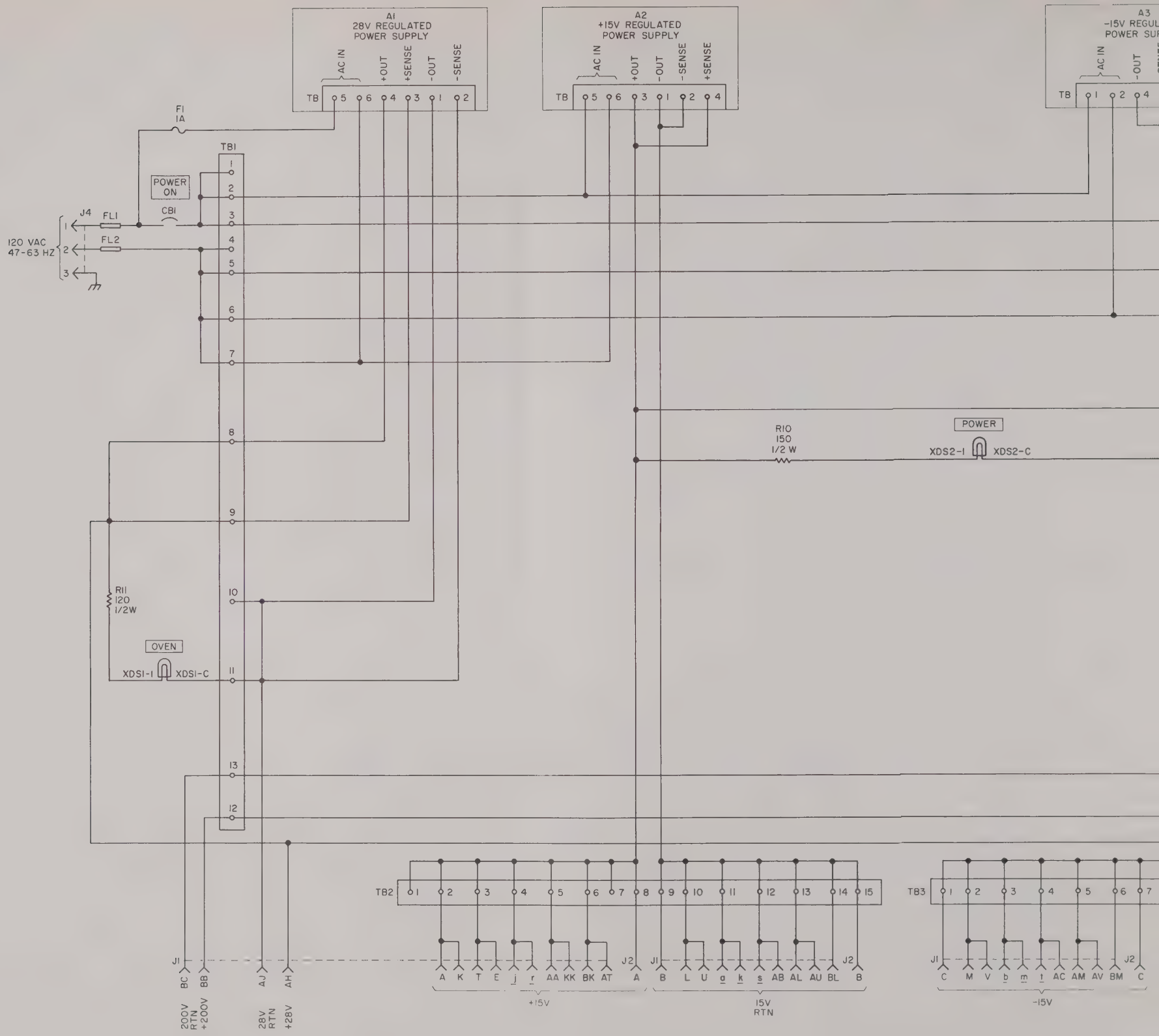
7-1. GENERAL.

7-2. This section contains drawings and other selected information to aid the technician in maintaining MFR regulated power supplies located in the MFR Power Supply Drawer A1.

7-3. Table 7-1 lists the drawings contained in Section VII.

Table 7-1. List of Drawings

FIGURE NO.	TITLE	NASA DRAWING NO.	PAGE
Figure 7-1	Power Supply Drawer A1 Schematic Diagram	1343593	7-3


A1
28V REGULATED
POWER SUPPLY
AC IN
+OUT
+SENSE
-OUT
-SENSE
TB
A2
+15V REGULATED
POWER SUPPLY
AC IN
+OUT
-OUT
-SENSE
+SENSE
TB
A3
-15V REGUL
POWER SUP
AC IN
-OUT
TB
F1
1A
TB1
POWER
ON
CB1
J4
FL1
FL2
120 VAC
47-63 HZ
R10
150
1/2 W
POWER
XDS2-1
XDS2-C
R11
120
1/2W
OVEN
XDS1-1
XDS1-C
TB2
TB3
J1
J2
BC
BB
AJ
AH
200V
RTN
+200V
28V
RTN
+28V
A K T E j r AA KK BK AT A
B L U g k s AB AL AU BL B
+15V
15V
RTN
C M V b m l AC AM AV BM C
-15V

343593

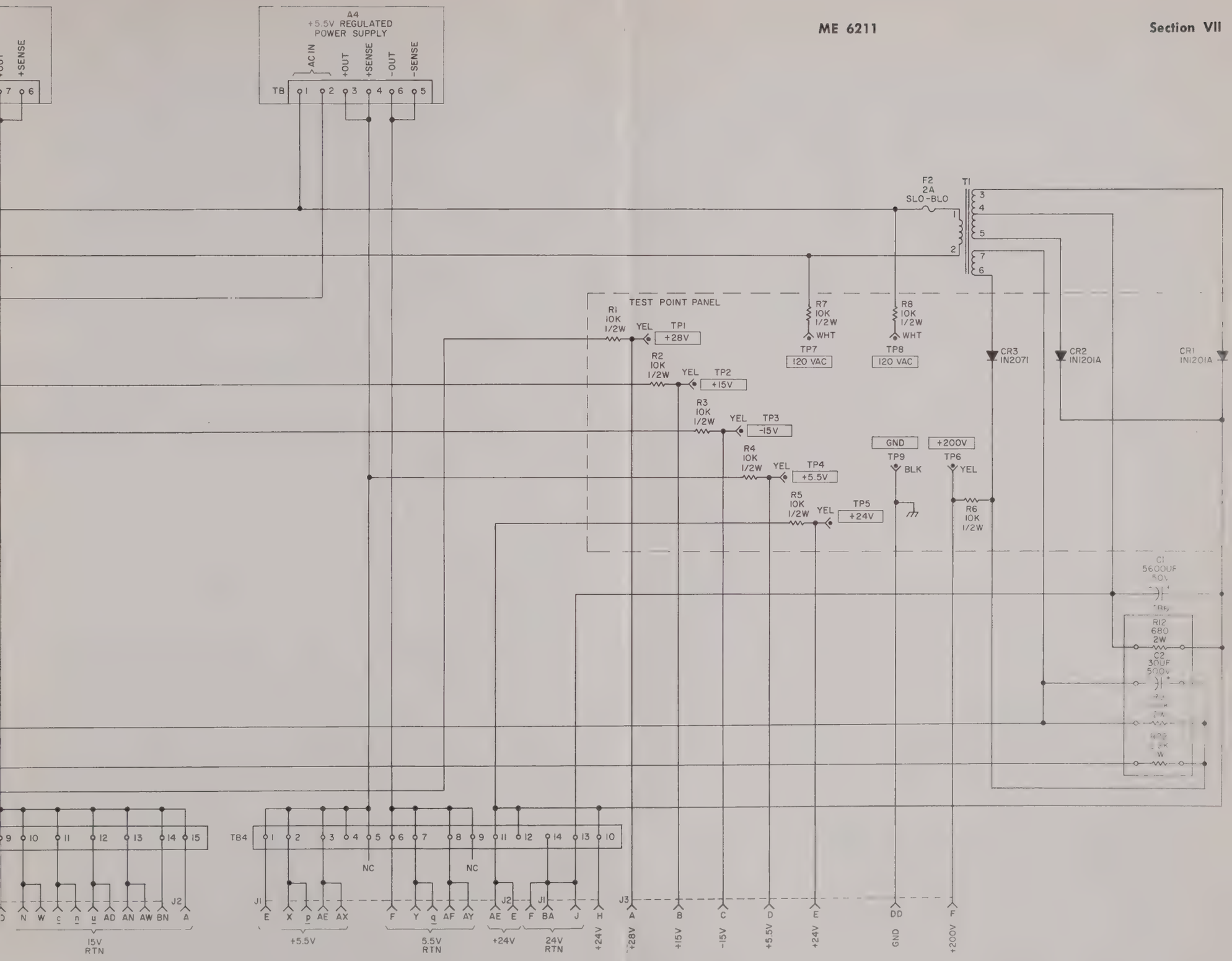


Figure 7–1. Power Supply Drawer A1 Schematic Diagram

Typeface Specimen Sheet

Use	Typeface	Type Size
Text/Tables	IBM Executive Typewriter, Boldface #2 Font	10 point
Section Titles, Heads for Table of Contents, List of Illustrations, and List of Tables	Futura Ultra Bold	14 point
Heads for Notes	Futura Ultra Bold	10 point
Primary Side Heads	Futura Bold	10 point
Marginal Copy	Futura Demi-bold	10 point
Figure and Table Titles	Futura Demi-bold Italic	10 point

EQUIPMENT DOCUMENTATION

(TECHNICAL MANUALS AND DRAWINGS)

CHANGE REQUEST SHEET

MANUAL OR DRAWING NO._____

Use this sheet to indicate changes or corrections which will update or improve technical manuals and drawings. When completed, mail the sheet to:

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: D. A. Naylor
Code 864.1

Comments: _____

Originator's Name: _____ Date: _____

Organization: _____ Title: _____

Address: _____ Location: _____
(If APO address or P. O. box)

_____

STDN No. 2010 (11/73)

Sheet____ of _____

EQUIPMENT DOCUMENTATION

(TECHNICAL MANUALS AND DRAWINGS)

CHANGE REQUEST SHEET

MANUAL OR DRAWING NO._____

Use this sheet to indicate changes or corrections which will update or improve technical manuals and drawings. When completed, mail the sheet to:

National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

Attention: D. A. Naylor
Code 864.1

Comments: _____

Originator's Name: _____ Date: _____

Organization: _____ Title: _____

Address: _____ Location: _____
(If APO address or P. O. box)

_____

STDN No. 2010 (11/73)

Sheet____ of _____